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PREFACE

The purpose of the *Population Bulletin of the United Nations,* as stipulated by the Population Commission, is to publish population studies carried out by the United Nations, its specialized agencies and other organizations with a view to promoting scientific understanding of population questions. The studies are expected to provide a global perspective of demographic issues and to weigh the direct and indirect implications of population policy. The *Bulletin* is intended to be useful to Governments, international organizations, research and training institutions and other bodies that deal with questions relating to population and development.

The *Bulletin* is prepared by the Population Division of the Department of International Economic and Social Affairs of the United Nations Secretariat and published semi-annually in three languages—English, French and Spanish. Copies are distributed widely to users in all member countries of the United Nations.

Although the primary source of the material appearing in the *Bulletin* is the research carried out by the United Nations Secretariat, officials of governmental and non-governmental organizations and individual scholars are occasionally invited to contribute articles.

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Explanatory Notes

Reference to "dollars" ($) indicates United States dollars, unless otherwise stated.

The term "billion" signifies a thousand million.

Annual rates of growth or change refer to annual exponential rates, unless otherwise stated.

A hyphen between years (e.g., 1984-1985) indicates the full period involved, including the beginning and end years; a slash (e.g., 1984/85) indicates a financial year, school year or crop year.

A point (.) is used to indicate decimals.

The following symbols have been used in the tables:

Two dots (. .) indicate that data are not available or are not separately reported.
A dash (—) indicates that the amount is nil or negligible.
A hyphen (-) indicates that the item is not applicable.
A minus sign (–) before a number indicates a deficit or decrease, except as indicated.

Details and percentages in tables do not necessarily add to totals because of rounding.

The following abbreviations have been used:

CBR	Crude birth rate
CELADE	Centro Latinoamericano de Demografía
DHS	demographic and health surveys
ECA	Economic Commission for Africa
ECE	Economic Commission for Europe
ECLAC	Economic Commission for Latin American and the Caribbean
ESCAP	Economic and Social Commission for Asia and the Pacific
ESCWA	Economic and Social Commission for Western Asia
FPA	Family Planning Association
GDP	Gross domestic product
GNP	Gross national product
GRR	Gross reproductive rate
IIASA	International Institute for Applied Systems Analysis
IPPF	International Planned Parenthood Federation
NAS	National Academy of Sciences
UNFPA	United Nations Population Fund
USAID	United States Agency for International Development
WFS	World Fertility Survey
WHO	World Health Organization

MEASURING THE QUALITY AND DURATION OF CONTRACEPTIVE USE: AN OVERVIEW OF NEW APPROACHES

*Shireen Jejeebhoy**

SUMMARY

This paper provides an overview of recently developed approaches to the measurement of contraceptive continuation and failure rates, using retrospective survey data rather than the data from clinical trials or programme statistics which are more traditionally used. The approaches fall into two categories, one relying on retrospective contraceptive histories and the other on current status information. The first section of the paper discusses the need for new methodologies; conventional applications using clinic and acceptor data are described, some recent results from the less developed countries presented, and their limitations illustrated. In the second section, each new approach is presented in terms of its data requirements, methods of calculation and empirical applications. Finally, potential sources of bias and the ability of the approaches to accommodate them are discussed.

The evaluation of the demographic impact of family planning programmes usually stresses the importance of contraceptive prevalence. However, the level of prevalence is not a sufficient measure of a programme's success. The impact of contraceptive use on fertility will depend not only on its prevalence but also on its reliability and the continuity of its use. There is some cross-country evidence which suggests that a consistent relationship between the level of contraceptive use and fertility does not always exist. Part of the reason for the apparent discrepancy is that increases in contraceptive use in some countries may be merely compensating for other fertility-enhancing trends, such as declining levels of lactation and postpartum abstinence (Bongaarts, 1987). A second, little-explored explanation is that some countries may combine high prevalence rates with high rates of discontinuation and use-failure among method acceptors.

Although family planning programme managers in less developed countries are increasingly able to determine the number of contraceptive

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users, serious questions remain regarding the length of contraceptive protection, use-failure and the consequences of contraceptive use for fertility. There is need therefore to provide planners and programme managers with improved, timely and comprehensive information on the quality and duration of contraceptive protection. Such information has a variety of policy implications: better monitoring and evaluation of programme activities; improved effectiveness in meeting the needs of users; and more generally, improved ability of Governments to achieve goals set for fertility and maternal and child health.

Conventional methods of examining the dynamics of contraceptive use have relied mainly on data obtained from prospective or retrospective clinical studies. Such studies have been valuable in that they have provided information on new methods under both ideal and actual conditions. However, they have had limitations in terms of being generalized and of methodology. In fact, remarkably little firm, representative information exists regarding the quality and duration of contraceptive practice in most less developed countries. The paucity of representative information prevails despite evidence from clinical trials of erratic use-patterns, wide cross-country variations in accidental pregnancies occurring following contraceptive use, and cross-cultural variations in use-effectiveness.

As non-terminal methods come to be used by increasing numbers of women in the less developed world, it is essential to have current and method-specific estimates of use-failure and continuation on a regular basis. Patterns of use by method may change as users become more comfortable with particular methods or as newer methods become available. Failure rates for methods which involve greater user-involvement, such as barrier methods or periodic abstinence, are higher in general but are, for that reason, likely to vary not only across populations but also within a population over time.

Recognizing the limitations of the conventional methodology and the importance of better measurement, a number of new analytical approaches have recently been proposed to measure contraceptive continuation and failure. They employ data obtained from retrospective fertility surveys rather than the prospective clinical trials or retrospective acceptor follow-up surveys that are traditionally used.

This paper provides an overview of the new approaches. It covers three basic areas. First, conventional applications using clinic and acceptor data are discussed, some recent results presented, and their limitations illustrated. Then each new approach is described in terms of data requirements, methods of calculation, empirical applications and their substantive results. Finally, potential sources of bias and the ability of the new approaches to accommodate them are presented.

Common terminology

Various terms are used to describe such features of contraceptive use as continuation and failure. The contraceptive continuation rate refers to the proportion of acceptors who are still using a particular method after a given period of exposure. Its complement, the discontinuation rate, measures the proportion no longer using a method for any reason, including failure or accidental pregnancy.

The failure of contraceptive use is measured in terms of accidental pregnancies occurring while contraception is practised or the ratio of unintended pregnancies to the duration of contraceptive exposure. Accidental pregnancy may occur as a result of method failure or user failure—that is, the degree to which a method is imperfectly used. Three types of failure rates are used: the narrowest is the method, or theoretical, failure rate (Tietze, 1971), which seeks to measure failure under ideal conditions by eliminating failures due to improper use.

A second and generally more appropriate measure of failure from the point of view of programme evaluation is the use-failure rate, or the number of accidental pregnancies occurring under average use conditions. It includes both method failure and user failure. The first-method-failure rate refers to failure and continuation, respectively, occurring during the use of the first contraceptive method observed in the study period. The all-method-failure rate allows for method switching and includes the period covered by both the first method and any subsequent methods used during the interval; the resulting rate is conventionally tabulated according to the first method used.

The third and broadest concept is extended-use failure or continuation. Extended-use failure includes all accidental pregnancies following acceptance of a particular method, regardless of whether the user had switched methods or whether use was interrupted or discontinued at the time of conception. Super-extended continuation rates (Laing, 1978) go even further and allow for the reintroduction to analysis of women who become pregnant if and when they resume contraception following the outcome of the pregnancy. The idea is to measure a method's attractiveness and user loyalty as well as its reliability during use.

Two contraceptive failure rates are commonly used in the literature: the Pearl pregnancy rate and life table rates. The Pearl pregnancy rate[1] is the number of accidental pregnancies per 100 years of exposure (Pearl, 1932). The problem with it is that it ignores the fact that failure rates typically decline with duration of use. Incomparable segments of experience and serious distortions may be introduced as a result. Wide differences in observed failure rates are attributed to variations in the number of months of exposure used. The measure therefore has limited meaning, unless it is used for a fixed duration of exposure, such as 12 months following the initiation of use.

The life table rate (Potter, 1966) involves the calculation of month-by-month failure rates. They are then chained together to provide a cumulative failure rate, or the proportion becoming pregnant within a given period—commonly 12 months. Values obtained for the 12-month life table rate are similar to those for the 12-month Pearl pregnancy rate.

An advantage of life-table methodology is that it facilitates the analysis of discontinuation for reasons other than failure. This is accomplished through the construction of both multiple- and associated single-decrement life tables. Termination rates from multiple-decrement life tables are called net rates; the net rate retains the confounding effects of termination for reasons other than pregnancy. Net termination rates from various causes add up to the total discontinuation rate. The net pregnancy rate, however, cannot be considered a pure measure of failure. Its value

declines with increases in terminations from other causes since those other causes eliminate the possibility of observing a subsequent accidental pregnancy. For that reason, the gross failure rate is a better measure. It assumes no competing risks by other causes of termination. Women who discontinue for any reason other than failure are censored at the time of exit, and the gross rate is calculated from the associated single-decrement life table.

BACKGROUND

Over the past decade, there have been at least two very extensive reviews of the literature on contraceptive-use patterns. The first is a review of the literature on family planning drop-outs, mainly in less developed countries (Kreager, 1977); the second is a very recent review of the literature on contraceptive failure in developed countries, primarily in the United States of America (Trussell and Kost, 1987). While the Kreager review presents mainly discontinuation rates from studies of clinic and programme acceptors, the Trussell and Kost review examines failure rates obtained from not only prospective and retrospective follow-up studies but also cross-sectional surveys, mainly in the United States. The present paper draws on those two reviews and considers some of the current studies on contraceptive failure and continuation from less developed countries.[2] The studies are based on either prospective trials (which follow up method acceptors on a regular basis for a fixed duration following acceptance) or retrospective follow-up studies (comprising a follow-up of acceptors after some duration of use in order to elicit their contraceptive experience since acceptance) of clinic or programme acceptors.

Tables 1 and 2 show the use-failure and continuation rates reported in those studies, along with the methodologies employed. Table 1 presents studies that have looked at more than one contraceptive method; table 2 presents method-specific studies. Altogether, 40 recent articles, published mainly in the past 10 years, are included, but they provide by no means an exhaustive list of the available evidence. Twelve-month rates are presented, though in many cases, rates for more months may also be reported.

The types of rates reported, as well as the types of data (prospective or retrospective) vary from study to study. For example, a variety of life-table rates—net, gross, extended, super-extended, first-method, all-method and Pearl ratios—have been reported, necessitating a cautious approach to comparisons of studies. Nevertheless, even when the differences are controlled, a wide range of values persists, underscoring the observation that failure and continuation rates are sensitive to cultural or socio-economic conditions and, as such, may change over time.

By and large, there is a tendency for recent studies to concentrate on newer methods—adaptations of the IUD, implants, injectables and some of the natural methods of family planning. The empirical results show some variation in failure rates and somewhat more variation in the case of continuation rates. Failure rates for such methods as injectables and implants are least variable, ranging between 0 and 1 per 100 years of exposure. In the case of IUDs, oral contraceptives, barrier and spermicide and periodic

abstinence methods, failure rates are considerably higher and also fall within a wider range. Net and first-method IUD and oral-contraceptive failure rates range from 0 to 5 and 12, respectively; gross and all-method rates are somewhat higher. Failure rates for barrier and spermicide methods are similar to those associated with periodic abstinence (rhythm) methods and range from 4 to 25 for first-method rates, and up to as much as 40 to 60 in the case of all-method and extended-failure rates.

Not all studies which report failure rates also report continuation rates (see tables 1 and 2). It is clear, nonetheless, that, to the extent that such non-terminal methods as oral contraceptives, barriers, spermicides and periodic abstinence are techniques which are inherently dependent on continuous use, continuation of those methods is ultimately a crucial indicator of the success of the programme. Where both failure and continuation rates are reported, it can be seen that continuation rates are subject to even wider variation than are failure rates.[3]

One explanation for the wide variation in observed rates is their sensitivity to the socio-economic and demographic composition of the sample, particularly age, parity, education, income and residence. In order to control for those variables, some studies have partitioned the sample into relevant subsets and have computed failure and continuation rates independently for each sub-sample.[4]

The results show that low continuation rates are not necessarily associated with high failure rates. For example, failure rates associated with injectables appear to be lower than those observed for most other methods; nevertheless, associated continuation rates are among the lowest, too. Conversely, periodic abstinence may be associated with high failure rates but also relatively high continuation rates.

Clinical studies and studies based on programme records—both prospective and retrospective—have met with a variety of problems which have detracted from their reliability and the ability to generalize from them (Trussell and Kost, 1987). A major problem is the selectivity of the sample. A clinical sample is very unlikely to reflect the contraceptive experience of the population at large. The sample will tend to be more motivated and have better access to contraceptive knowledge; consequently, it will get different results from the same contraceptive. Even among contraceptors, the more motivated are likelier to select more efficient methods, thereby accentuating method-specific differentials.

A more serious problem concerns the potential selectivity of those who become lost to follow-up. By and large, the proportion becoming lost is large in clinical studies; rates as high as 35 per cent and even 60 per cent are noted in table 1. The conventional approach is to assume that women lost to follow-up experience accidental pregnancies at the same rate as those who continue under observation. As a result, they are censored as continuing users, as of the last observation. However, it is just as plausible to argue that women who become pregnant are more motivated to report the fact and therefore less likely to become lost to follow-up; or, alternatively, they may be more likely to become dissatisfied with the clinic and drop out of the observation study.[5]

Yet another problem associated with clinical follow-up surveys is their concentration on programme-assisted contraception. The experiences

TABLE 1. USE-FAILURE, CONTINUATION AND USE-EFFECTIVENESS RATES: PROSPECTIVE AND RETROSPECTIVE FOLLOW-UP STUDIES OF ACCEPTORS

Country	*Year*	*Author*	*Sample size*	*Data*	*Prospective (P) or retrospective (R)*
					Failure
Bangladesh	1977-1980	Bhatia and others, 1984	4 870	Programme	P
Matlab Thana					
Caribbean	1979	Bailey and others, 1982			
St. Kitts-Nevis			736	Clinic	P
St. Vincent			688	Programme	R
Indonesia	1973-1974	Sullivan and others, 1976	2 381	Programme[b]	R
(Mojokerto)				Drive	
				Programme	
				Drive	
Indonesia	1975	Teachman and others, 1979	1 500	Programme[c]	R
				Clinic	
Indonesia	1975-1976	Teachman and others, 1980	2 160	Clinic	R
Mexico	1973-1974	Gallegos and others, 1977	2 260	Programme:	R
			7 899	2 surveys	
Morocco	1972-1973	Lecomte and others, 1976	1 001	Programme	R
Tunisia	1973-1974		1 226		
Philippines	1974	Phillips, 1978	2 951	Programme	R
Philippines	1974	Laing, 1978	2 987	Programme	R
Philippines	1976	Laing, 1984	..	Programme	R
Thailand	1975-1976	Somboonsuk and others, 1978	2 879	Programme	P
Thailand	..	Anonymous, 1982	..	Clinic	P
					Continuation
Bangladesh	1977-1980	Bhatia and others, 1984	4 870	Programme	P
Matlab Thana				Domicile visit	
Caribbean	1979	Bailey and others, 1982			
St. Kitts-Nevis			736	Clinic	P
St. Vincent			688	Programme	R
Indonesia	1973-1974	Sullivan and others, 1976	2 381	Programme	R
(Mojokerto)				Drive	
				Programme	
				Drive	
Indonesia	1975	Teachman and others, 1979	1 500	Programme[b]	R
				Clinic	
Indonesia	1975-1976	Teachman and others, 1980	2 160	Clinic	R
Mexico	1973-1974	Gallegos and others, 1977	2 260	Programme:	R
			7 899	2 surveys	
Morocco	1972-1973	Lecomte and others, 1976	1 001	Programme	R
Tunisia	1973-1974		1 226		

Rate	*Percentage loss follow-up*	*Total*	*IUD*	*OC*	*Condom*	*Foams, diaphragm*	*Periodic abstinence*	*Withdrawal*	*Injectables, implants*
rates									
Gross	..		1	11	24				2
Net	28								
		1	[a]	1	4				
		3	7	2	..				
1st	6.5		5	14					
1st			8	21					
Extended			6	16					
Extended			8	25					
Extended	..		5	18					
			4	19					
Gross	17.7	14	5	18	22				
Net: 1st	57		3-4	2-3					
Net: all	51		4-6	3-4					
Gross	44		12	30					
Net			2	7					
Gross	40		14	31					
Net			3	4					
All: unadjusted	37								
All: adjusted									
1st method	37		3	5	12		21		
All methods			5	10	17		21		
Extended			10	26	40		28		
Net	..		2	5	10		14		
Extended			13	28	40		36		
Net	IUD = 8 OC = 23 Inj = 11		0	0					0
Gross	..		1	1					0
rates									
1st			55	30	20	42			60
1st									
		57	76	52	42 [c]				
		68	70	68					
1st			85	59					
1st			81	48					
Extended			89	66					
Extended			87	53					
1st			90			63[d]			
Method			88			66[d]			
1st		72	90	64		56			
All		76	92	66		63			
1st			70-78	40-49					
All			84-86	72-78					
1st			71	45					
All, extended			77	52					
1st			72	44					
All, extended			78	56					

TABLE 1 *(continued)*

Country	*Year*	*Author*	*Sample size*	*Data*	*Prospective (P) or retrospective (R)*
Philippines	1974	Phillips, 1978	2 951	Programme	R
Philippines	1974	Laing, 1978	2 987	Programme	R
Philippines	1976	Laing, 1984	..	Programme	R
Thailand	1975-1976	Somboonsuk and others, 1978	2 879	Programme	P
Thailand	..	Anonymous, 1982	..	Clinic	P

[a] Less than 1 per cent.
[b] Results refer to failure rates observed in the regular programme and in special drives within the programme.

TABLE 2. TWELVE-MONTH METHOD-SPECIFIC FAILURE AND CONDINUATION RATES: REVIEW OF RECENT PROSPECTIVE AND RETROSPECTIVE FOLLOW-UP STUDIES OF ACCEPTORS

Country	*Year*	*Author*	*Sample size*	*Data*
				IUD
Less developed countries...	1970s	Liskin and others, 1982	..	Review
Chile.....	..	Edelman and others, 1977	821	Clinic
Bangladesh	..	Khan and others, 1979	121	Clinic
Chile.....	..	Medel and others, 1978	471	Clinic
Colombia	..	Sivin, 1976	775	Clinic
Iran, Islamic Republic of	..	Sivin, 1976	719	Clinic
Republic of Korea	..	Sivin, 1976	1 050	Clinic
Thailand.....	..	Sivin, 1976	1 996	Clinic
Chile.....	..	Tacla and others, 1978	200	Clinic
Bangladesh[a]	..	Mabud and others, 1984	999	Programme
China	1982	Sung and others, 1985	892	Clinic
			887	
			983	
Colombia	1971-1972	Measham and others, 1976	600	Clinic
			426	
			600	
India[a]	..	Shastry, 1976	1 624	Programme
Bombay				
Iran, Islamic Republic of	1975	Zeighami and others, 1976	232	Programme: midwife
			232	Clinic
Malaysia	1980s	Goh and others, 1985	1 725	Programme
Ibadan, Nigeria.....	1965-1968	Ojo, 1980	628	Programme
	1968-1970		529	
Nigeria	1983	Ololorin and others, 1985	100	Clinic
			100	
Sudan[a].....	..	Gerais and others, 1983	67	Clinic
			69	

Rate	Percentage loss follow-up	Total	IUD	OC	Condom	Foams, diaphragm	Periodic abstinence	Withdrawal	Injectables, implants
All: unadjusted		80	52		37		56		
All: adjusted		78	54		39		51		
1st method		72	53	29			60		
Extended, all		84	63	51			66		
Super-extended	70	85	66	58			73		
1st method		68	48	23			42		
All, extended		81	61	51			57		
1st		67	72						75
1st		75	68						79

[c] Including barrier/spermicide, periodic abstinence and withdrawal.
[d] Including oral contraceptives and foaming tablets.

	Prospective (P) or retrospective (R)	Type of rate	Method of contraception	Failure	Continuation	Loss to follow-up
IUD						
	P	Net		1-5	50-85	..
	P	Gross	TCu200	3		
	P	Net	TCu220C	0	58	..
	P	Net	TCu200	3	83	..
	P	Net	TCu200	2	83	..
	P	Net	TCu200	3	79	..
	P	Net	TCu200	1	72	..
	P	Net	TCu200	1	69	..
	P	Net	TCu200	2	73	..
	P	Net			80	..
	P	Net	TCu380Ag	0.20[b], [c]	86[b]	..
			TCu220Ag	1[b]	91[b]	
			Mahua Ring	4[b]	83[b]	
	R	Net	TCu200	4[d]	66[d]	4[d]
			Dalkon Sh	5[d]	61[d]	
			Lippes Lp	5[d]	63[d]	
	R	Net		0		..
	R	Net		[c]	75	9
				2	75	2
	P	Net	ML Cu250	2[d]	74[d]	6[d]
		Gross	TCu 220C	2[d]	73[d]	7[d]
			Cu7	5[d]	69[d]	8[d]
	R	Net	LL3C	3	86	10
			M-211	1	84	6
	P	Net	After MR	0	78	..
			Interval	0	80	..
	P	Net	Lippes Lp	0	70	35
			Cu 7	0	73	40

TABLE 2 *(continued)*

Country	*Year*	*Author*	*Sample size*	*Data*
				Oral
Bangladesh	1978	Measham and others, 1980	390	Clinic
Brazil	..	Santoretto and others, 1977	930	Clinic
Brazil: Rio Grande do Norte	1977	Gorosh and others, 1979	931	Clinic[b]
			1 112	CBD
Sri Lanka	1978-1980	Basnayake and others, 1984	201	Clinic
			181	
WHO sites	..	WHO, 1980	925	Clinic
Bangkok				
Bombay				
Singapore				
Szegad (Hungary)				
Less developed countries	1960s	Jones and Mauldin, 1967		
Sri Lanka		Rao, 1965	651	Clinic
Turkey		Ross, 1967	2 158	Clinic
Bombay (India)		Kanitkar, 1966	324	Clinic
				Barrier methods
More developed countries/ less developed countries	1970s	Sherris and others, 1984		Review
Bangladesh		Begum and others, 1980	150	Clinic
Bangladesh, Taiwan Province, Yugoslavia		Feldblum, 1983	698	Clinic
Accra, Chana	1982	Lamptey and others, 1985	99	Clinic
			101	
			100	
				Periodic
Less developed countries/ more developed countries	..	Betts, 1984	..	Review
Colombia	..	Medina and others, 1980	..	Clinic
Total		WHO, 1981	..	Clinic
Dublin				
Auckland				
Manila				
Bangalore				
San Miguel				
More developed countries/ less developed countries	1970s	Liskin and others, 1981	..	Review of periodic abstinence studies
Chile[a]	1981-1983	Perez and others, 1983	660	Special programme
India[a] (Tamil Nadu)	..	Bernard, 1978	1 000	Clinic
Philippines	1971	Laing, 1984	142	Clinic

Prospective (P) or retrospective (R)	Type of rate	Method of contraception	Failure	Continuation	Loss to follow-up
contraceptives					
P	Net			40	22
P	Net		1	53	21
P	1st method			47	
R	1st method[e]			54	
R	1st method[f]			55	63
R	Extended			61	
P	1st method			42-75[g]	13
				33-51[h]	
P	Net		1	48	..
	Review				..
P	1st method			76	
P				12	
P				53	
and spermicides					
					..
P	Gross	Neosampoon	6		
P	Gross	Neosampoon	11		
P	Gross	Neosampoon	10	62	19
		Ortho VT	11	49	22
		Emko VT	12	38	23
abstinence					
					..
P	Pearl	Billings	24	40	
		Symptothermal	20	47	
P	Pearl	Billings	22		
			18		
			31		
			18		
			19		
			33		
P		Cerv muc	6-27	26-100	..
		Symptothermal	3-20	24-62	
P	Pearl		17		..
					..
P	Net	Billings	0	100	..
R	Gross	BBT[i]	24	32	..
		BBT[j]	40	41	..
		Calendar[i]	27		
		Calendar[j]	38		

TABLE 2 *(continued)*

Country	*Year*	*Author*	*Sample size*	*Data*
				Inject
WHO sites	..	WHO, 1977	832	Clinic
10 centres[a]			846	
Bangladesh[a]	..	Parveen and others, 1977	2 000	Clinic
Bangladesh		Rahman and others, 1985	913	Clinic
India[a]	1981-1983	ICMR Task Force, 1984	1 207	Clinic
			1 181	
Mexico (rural)	1979-1981	Meade and others, 1984	5 792	Clinic
Pakistan	..	Kazi and others, 1985	2 147	Clinic
South Africa, Stellenbosch	..	Rall and others, 1977	19 875	Clinic
Thailand	1978	Narkavonnakit and others, 1982	624	Programme/ clinic
				Implants and
Chile, Dominican Rep., Brazil, Finland, USA	1980s	Robertson and others, 1985	189	Clinic
Brazil, Jamaica, Finland, Chile, Dominican Rep.	1977-1981	Sivin and others, 1982	990	Clinic
Chile	1980s	Diaz and others, 1986	458	Clinic
China	..	Ji and others, 1986	108	Clinic
Colombia	1982-1984	Lopez and others, 1986	389	Clinic
Ecuador	1981-1982	Marangoni and others, 1983	283	Clinic
			283	
Egypt (Assiut)	1980-1981	Shaaban and others, 1983	250	Clinic
			100	
India[a]	..	Takkar and others, 1978	876	Clinic
Thailand	1982	Satayapan and others, 1983	704	Clinic

NOTES: Cerv muc = cervical mucus; BBT = basal body temperature.
[a] Information available from abstract only.
[b] 18-month rate (12-month rate not reported).
[c] Less than 1 per cent.
[d] 24-month rate (12-month rate not reported).
[e] Programme source.
[f] All sources.
[g] Standard dose.

Prospective (P) or retrospective (R)	Type of rate	Method of contraception	Failure	Continuation	Loss to follow-up
ables					
P	Gross	NET-EN	4		
		DMPA	1		
P	Net	DMPA	0	56	..
P	Net	NET-EN	[c]	63	9
P	Net	NET-EN[k]	0	31[d]	..
		NET-EN[l]	1	32[d]	
P	Net	NET-EN	[c]	43	16
P	Net	NET-EN	0	22	19
P	Net	[i]	[c]	32	53[m]
		[n]	[c]	28	66[m]
R	Net	DMPA	0	59	38
vaginal rings					
P	Net	Norplant	0	78	..
P	Net	Norplant	[c]	77	1
P	Pearl	Norplant	0		..
P	Net	[h]	4	71	0
		Vaginal Ring			
P	Net	Norplant	0	92	5
P	Net	Norplant	0	87	..
		TCu200	2	88	
P	Net	Norplant	1	90	7
		TCu380Ag	1	86	6
P	Net	Implant D	4	86	..
P	Net	Norplant	[c]	88	21

[h] Low dose.
[i] First period of use.
[j] All periods of use.
[k] 2-monthly.
[l] 3-monthly.
[m] Includes personal reasons along with loss to follow-up.
[n] 6-monthly.

of contraceptors who obtain supplies from commercial or other distribution outlets are not included in the measurements, and prevalence rates obtained from service statistics are consequently lower than those obtained from survey data.

One means of reducing these biases is to utilize more representative data, of the sort collected in retrospective cross-sectional surveys, for the estimation of method failure and continuation rates. There are three major advantages of this approach:

(*a*) the sample is drawn from the general population, reducing the selection bias;

(*b*) there is no problem of loss to follow-up;

(*c*) both programme and non-programme acceptors are included.

Table 3 presents the results of studies based on retrospective survey data. Several of the studies reported are based on United States data and have also been reported in the Trussell and Kost (1987) review.

Trussell and Kost conclude that failure rates derived from survey data tend to be higher than those reported in clinical trials, especially for methods which are coitus-dependent. This difference is attributed to different sampling procedures, with clinical studies attracting a more motivated sample; the possibility that women in prospective surveys may be more careful simply because they are regularly followed-up on; and the fact that pregnancies in the two cases are not counted in the same way.

New methodologies

Recent demographic research has pointed to the potential of fertility surveys to provide more comprehensive data, at a small marginal cost, for the evaluation of contraceptive-use dynamics, specifically use-failure and continuation rates. New methodologies, ranging from the simple to the complex, have been developed to analyse the data, both in terms of their design and in terms of the additional data required from surveys. Essentially two broad kinds of methodology have evolved. The first are retrospective-history methods which involve manipulations of retrospective contraceptive history data. Three methodologies fall into this group:

(*a*) modifications of conventional life-table methods, which are the most extensively applied;[6]

(*b*) the contraceptive-status-calendar method (Laing, 1984; 1985), which is a cross-sectional and non-life-table approach;

(*c*) the analysis of sexual activity tables (Gaslonde and Carrasco, 1982), which analyses the roles played by contraception and absence of sexual relations in lowering pregnancy rates. The second kind of methodology is the current-status method proposed by Bongaarts (1984). It assesses contraceptive failure rates—or, more precisely, average annual use-failure rates—from information on recent fertility and contraceptive behaviour.

The following discussion describes the two kinds of methodology, their data requirements and their applications, in terms of use-failure and continuation.

Data

A fundamental distinction between the two basic methodologies is the kind of data required by each and the means by which the data are collected. Retrospective-history methods require quite detailed information on past fertility and contraceptive behaviour, while the current-status method relies primarily on information about current or recent behaviour.

Retrospective-history methods require, by and large, information on the months of use and non-use and corresponding information on pregnancy, exposure, infecundability and sterility. The reference period for most of the applications of the methods is gauged either by time (over the past x years), fertility histories (over the last x birth or pregnancy intervals or for all intervals from a particular date to the time of interview) or contraceptive histories (over the last x methods used). At the very least, the following information is solicited by the method:

(*a*) fertility information;

(*b*) months of use;

(*c*) whether pregnancy occurred while method was being used;

(*d*) non-susceptible months when contraception was used. (This is less often asked and includes months of post-partum amenorrhea, abstinence, temporary separations and sterility.)

Retrospective-history methods obtain this information in two different ways, and the distinction may be important empirically. The first and more conventional source is a series of unique modules on such issues as contraceptive behaviour, pregnancy and fertility histories and, less often, lactation, amenorrhea and abstinence, such as those developed in the World Fertility Survey programme. A month-by-month history of exposure or a life table showing the number/proportion of women continuing contraceptive use for each duration since its initiation is approximated by piecing together the relevant data. By and large, modified life-table techniques utilize data in that form.

The second and more elaborate means of eliciting the information is by means of detailed calendar format in which events such as contraception, pregnancy, amenorrhea and so on are reported simultaneously for each month. This system of data collection is employed in the applications of the contraceptive-calendar method and the sexual-activity tables, though any data so collected would be equally suited for the application of life-table analyses. The data required for the contraceptive-status-calendar method (Laing, 1984; 1985) are obtained in the form of a monthly family planning and pregnancy record. The monthly record is literally a calendar that registers the state in which the respondent found herself during up to 30 months prior to the survey. The states include not only contraception, method used and pregnancy status, but also sexual activity, amenorrhea, perceived infecundity or sub-fecundity and desire for pregnancy.

The sexual-activity-calendar method (Gaslonde and Carrasco, 1982) is somewhat similar to the Laing contraceptive calendar and also provides a monthly record of contraceptive practice. Unlike the Laing continuous record, the sexual-activity calendar is constructed with a series of ordered questions on pregnancy, abstinence and contraception over a 12-month reference period.

TABLE 3. TWELVE-MONTH USE-FAILURE RATES: REVIEW OF RESULTS BASED ON RETROSPECTIVE CROSS-SECTIONAL SURVEY DATA

Country	*Year*	*Author*	*Sample size*	*Method*	*Data*
					Retrospective
Life table methodology					
1. Latin America.....		Goldman and others, 1983	1 322	Extended	WFS
Colombia.....	1976		300		
Costa Rica.....	1976		332		
Dominican Rep.	1975		130		
Panama.....	1977		317		
Peru.....	1977-1978		190		
2. Bogotá, Colombia..	1974	Bailey and others, 1976	1 830	Net	
3. Mauritius.....	1985	Wong and others, 1987	3 280	Gross	CPS
4. Belgium	1971	Cliquet and others, 1977	3 397	Gross	NEGO II
5. Flanders, Belgium..	1975-1976	Cliquet and others, 1983	4 463	Gross	NEGO III
6. Flanders, Belgium..	1982-1983	Lodewijckx and others, 1987	3 101	Gross	NEGO IV
7. England and Wales	1975	Bone, 1978	3 898	Extended	Survey
8. United States.....	1970-1973	Vaughan and others, 1977	6 302 intervals	Extended	NSFG I
9. United States.....	1970-1973	Trussell and Menken, 1982		Gross Pearl	NSFG I
10. United States.....	1970-1973	Trussell and others, 1981	2 263	Gross Logit	NSFG I
11. United States.....	1970-1975	Schirm and others, 1982	8 298 use intervals	Gross	NSFG I,II
12. United States.....	1970-1975	Grady and others, 1983	9 797 8 611	Gross	NSFG I,II
13. United States.....	1975	Jones and others, 1980	3 403 (6 122 use segments)	Gross	NFS 1975
14. United States.....	1982	Grady and others, 1986	5 269 (3 537 use intervals)	Gross Hazards	NSFG III 1982
15. United States.....	1982	Hammerslough, 1987	7 969	Gross Hazard si	NSFG III
Contraceptive status calendar					
Philippines.....	1980	Laing, 1985	4 320		COS
Sexual-activity tables					
Venezuela.....	1977	Gaslonde and Carrasco, 1982	4 361		WFS

Sub-population	*Total*	*IUD*	*OC*	*Condom*	*Barrier/ spermicides*	*Rhythm*	*Withdrawal*	*Injectables*
history methods								
		5	8	13	15	19	17	12
		8[a]		14[a]		17[a]		
	10	9[a]		13[a]		21[a]		
	5	3[a]		11[a]		13[a]		
	13	8[a]		18[a]		29[a]		
	11	10[a]		20[a]		17[a]		
	12	11[a]		12[a]		14[a]		
		3	1		Other = 7			
			4			16		0.4
Aged 30-34	18		4			25	17	
		2	1	6		27	19	
	6	4	1	4		——13——		
		9	5	11	14		20	
		4	2	10	15	19		
Preventer	4	3	2	7	13	10		
Delayer	7	6	2	14	17	29		
Preventer	4	3	2	7				
Preventer		3	2	7				
Unstd[b]	8	5	2	13	18	21		
Std:se/d[c]	7	5	2	12	15	20		
		5	2	10	18	24		
	6	5	2	10	18	19		
Preventer	4	2	2	7	17	12		
Delayer	8	7	2	12	18	25		
Delayer <25	11	—4—		22		31		
Preventer <25	12	—3—		12		29		
Delayer 25+	7	—3—		10		26		
Preventer 25+	2	—2[d]—		3[e]		8		
Unstd[b]	7		4	11	20		9	43
Std:se/d[c]	6		3	14	22		16	40
Adjust:ab[h]	6		3	14	22		16	41
Unstd[b]	6		4	9	18		10	
Std[c]	6		3	10	25		12	
		4	19	60		33	——44——	
		4	7	8		20		
IUD and OC	5							
Other	15							

TABLE 3 *(continued)*

Country	*Year*	*Author*	*Sample size*	*Method*	*Data*
					Current
Latin America		Bongaarts, 1984			WFS
Dominican Rep.....	1975		130		
Peru	1977-1978		190		
Costa Rica	1976		332		

NOTE: Four countries give results on selected sub-populations: as follows: 8, 9, 12 — contraceptive intentions; 13 — contraceptive intention and age; 4 — age only.

WFS World Fertility Survey
CPS Contraceptive Prevalence Survey
NEGO Quinquennial Probability Survey on Fertility Behaviour
NSFG National Survey of Family Growth
COS Community Outreach Survey

[a] The following rates have been grouped: IUD, oral contraceptive and injectable failure rates are reported under "IUD"; condom, diaphragm and spermicide under "condom"; rhythm and withdrawal under "rhythm."

In contrast to those relatively demanding data schedules, Bongaart's current-status method for estimating contraceptive failure rates imposes few additional data requirements on a conventional fertility survey and utilizes the current-status information—births in the past two years, current contraceptive status and contraceptive status at conception—conventionally available in such surveys. As a result, the measure is relatively robust to dating errors, since recall of dates or duration of contraceptive use and non-use is not required.

Measurement of use failure rates

Life-table methodology

Table 3 reproduces failure rates—including use and extended use—as obtained by studies using standard life-table methodology. For several of the United States studies, failure rates standardized for socio-economic and demographic factors have also been presented, utilizing multivariate life-table techniques (Grady and others, 1986; Hammerslough, 1984; Trussell and others, 1981; Schirm and others, 1982). Each of the studies reported in table 3 has adapted conventional life-table measures as originally proposed by Potter (1966). In brief, contraceptive status (including continuation, method failure, expulsion, removal and, in the case of clinical studies, loss to follow-up) for each month following the initiation of use is recorded. At the time of analysis, women are classified according to their status at last observation. In this procedure, monthly failure rates are calculated and their complements are chained together to provide a cumulative failure rate within a given period (Trussell and Kost, 1987).

Life-table methodology has been applied to a number of cross-sectional data sets and has been extensively discussed by Trussell and

Sub-population	*Total*	*IUD*	*OC*	*Condom*	*Barrier/ spermicides*	*Rhythm*	*Withdrawal*	*Injectables*
status method								
	12		13					30
	18		12			22		20
	12		8	16		28		27

[b] Unstandardized.
[c] Standardized for socio-economic and demographic variables.
[d] IUD and OC.
[e] And diaphragm.
[f] And all others.
[g] No method.
[h] Also adjusted for abortion under-reporting.

Menken (1980; 1982). In the survey situation, cross sections of women who have been using contraceptives for various lengths of time are observed. The construction of a multiple-increment life table allows all segments of use to be included. The experience of a woman who enters the observation period at month y is only included in the life table at months y and later. It is assumed here that women who enter observation at month y are representative of all continuing contraceptors at month y.[7]

Contraceptive-status calendar

Failure rates obtained using contraceptive-status calendars on data from the Philippines are presented in table 3. The monthly failure rate is the number of conceptions occurring in a month while contraception is used, as a proportion of the total number of non-amenorrheic users (including the failures) in that month. Given the lack of variation in the monthly rates, an average monthly failure rate (MFR) is calculated by aggregating the results for all possible pairs of successive months to give a single rate, by dividing the sum of all the numerators by the sum of the corresponding denominators. In order to be comparable with other rates reported in the literature, monthly rates are converted into the equivalent of an annual Pearl pregnancy rate—PPR = 1,200 (MFR)—interpreted as the number of failures occurring per 100 years of use. Resulting failure rates reported in table 3 tend to be considerably higher than those reported via life-table methodology, despite the fact that life-table rates always include the relatively high-risk period immediately following acceptance. While Laing's failure rates are average, given the prevailing distribution of use, and are not computed at various durations following method acceptance, the data are extensive and sufficient to compute duration-specific life-table failure rates.

Sexual-activity tables

In the approach using sexual-activity tables, each woman-month of exposure is assigned according to a hierarchy of reproductive states; pregnancies are allocated by contraceptive status at conception, excluding months of no exposure. All events are viewed as a proportion of woman-months of exposure rather than of users. Failure rates are measured by an adaptation of the Pearl pregnancy rate. Rates are computed from the WFS survey in Venezuela and are reproduced in table 3. Failure rates are measured as follows:

$$\text{Probability of pregnancy} = 1{,}200 * \frac{\text{Pregnancies in women using contraceptives}}{\text{Woman-months with contraceptives}}$$

In effect, this rate resembles Laing's PPR described above. The only difference is that there is no provision for excluding the overlap between contraception and abstinence (available in the sexual-activity table) or post-partum amenorrhea (which is not available). The resulting method-based failure rates reported for Venezuela are consistent with other estimates and range from 3.64 for IUDs to 46.87 for tablets and foams.

Current-status method

The current-status method assesses contraceptive failure rates or, more precisely, average annual use-failure rates. The failure rate is obtained from the proportion of births reported by women who were using contraception during the two years prior to the survey. Only four items of data are required:

(*a*) monthly number of births to women who were using contraception at the time of conception (B');

(*b*) total number of women using contraception at the time of the survey (U);

(*c*) monthly total number of births to all women (B);

(*d*) number of currently married women in the reproductive ages (W). A constant ($a = .83$) (Bongaarts and Potter, 1983), representing the average proportion of conceptions which result in live births, is applied to convert births into pregnancies.

The method can be outlined as follows:

(*a*) Estimation of the monthly probability of conceiving with contraception:

$$f = pB/Ua$$

where $p =$ proportion of all births B which are accidental (B') or $p = B'/B$.

and $pB/a =$ the number of pregnancies which resulted in the total number of accidental births, B'.

(*b*) Estimation of the monthly probability of conceiving with contraception, among currently married women, by dividing both numerator and denominator from above by the number of currently married women:

$$f = pb/ua$$

where $b = B/W$, the monthly birth rate among married women;
$u = U/W$, contraception rate among married women.

(*c*) Estimation of the average annual failure rate F, calculated from f using Ryder's (1973) equation:

$$F = 1 - (1 - f)^{12}$$
$$= 1 - (-pb/ua)^{12}$$

This methodology has been applied to WFS data from several countries, and failure rates are reported in table 3. While the description above assumes that only one method is in use and calculates use-failure rates, both method-specific and extended-use-failure rates can be computed by making appropriate changes in the parameters p and u.[8]

An assumption of this method is that the reproductive process is in a steady state, so that the number of users (u) at the time of the survey is expected to be constant over the previous two years. In many less developed countries, where prevalence rates are reported to increase by up to 2 per cent a year (United Nations, 1987), this assumption could bias the failure rate downward. It may be possible, however, to assume an annual rate of increase in prevalence and adjust u accordingly.

The advantages of this method are that it is simple, makes few demands on data and is easily interpretable. The method makes use of the most reliable data available—that is, births rather than conceptions and contraceptive use at the time of conception rather than information based on monthly use patterns. Unlike standard life-table methodology, it does not require such standard information as timing of onset and termination of segments of use. Nor does it require detailed contraceptive histories, as in the case of the contraceptive-calendar method.

Results

Table 3 reports a range of failure rates which vary not only by methodology but also by locale and timing. A cursory look at the rates suggests that life-table rates are fairly consistently lower than corresponding rates derived by either the current-status or, especially, the contraceptive-calendar-status methods. Whether those differences arise from variations in methodology or locale needs further investigation.[9]

In addition, two comparisons are of particular interest. The first is a comparison of failure rates for the Philippines as obtained from cross-sectional data using the calendar-status methodology with retrospective acceptor follow-up data, using life-table methodology as presented in table 1. The second is a comparison of life-table and current-status rates for several Latin American countries using identical WFS data.[10]

In the Philippines example, Laing's (1984; 1985) calendar method, applied to retrospective cross-sectional survey data, gives consistently higher failure rates than life-table rates on acceptor data, despite the fact that the latter surveys were conducted from four to six years earlier. Though not entirely comparable, the consistency and occasional magnitude of the differences warrant further investigation into the calendar-status method. Of particular interest would be the application of life-table methodology to the cross-sectional 1980 survey and a comparison of the resulting rates with the calendar-status rates.

In the Latin American example, information on three countries—Costa Rica, Dominican Republic and Peru—is available, using both retrospective history (life table) and current-status methodology on the same WFS data sets. A total of seven comparable rates are presented: the overall failure rates for all three countries, the oral contraceptive and condom failure rates for Costa Rica and the rhythm and withdrawal rates for Costa Rica and Peru. In only two cases do the rates obtained by the two methodologies tally: total failure rates for the Dominican Republic (11.9 and 13 for the current-status and life-table methods, respectively), and oral contraceptives in Costa Rica (8.1 and 8, respectively). In the remaining five cases, the current-status estimates are consistently higher than the life-table estimates, and the differences range from 6 to 15 points. Two explanations may be offered to account for the differences. First, the current-status method adjusts for abortion, an adjustment that is absent in the life-table rate. Omitting it from the Bongaarts (1984) estimation procedure results in a decline of two points (from 12.1 to 10.1) in Costa Rica's total failure rate. Secondly, the extended life-table rates include the period immediately following a birth, when the effect of contraception is redundant since it overlaps with amenorrhea. That issue has little bearing on the current-status estimates.

Measurement of continuation rates

In contrast to the measurement of use failure, the estimation of continuation rates continue to rely, for the most part, on life-table methodology (Tietze, 1967; 1973; Potter, 1966). The current-status method thus far does not permit the computation of continuation rates. Even among the retrospective-history methods, only Laing's (1985) contraceptive-status calendar proposes and applies an alternative way of calculating an annual continuation rate. Table 4 presents continuation rates measured by life-table techniques and Laing's calendar-status method.

Life-table techniques for estimating continuation follow from the methodology outlined earlier for estimating failure (Trussell and Menken, 1980). Unlike life-table methodology, Laing's contraceptive-status-calendar method (Laing, 1984; 1985) does not provide estimates of continuation at various durations following method acceptance but gives estimates of average rates given the prevailing distribution of use. The methodology calculates a method-specific average annual continuation rate. The monthly continuation rate is calculated as the proportion of contraceptors in any month who are still using that method in the next month. Given the lack of variation in monthly rates, an average monthly rate (MCR) is computed by

aggregating the results for all possible pairs of successive months to give a single rate, dividing the sum of all the numerators by the sum of the corresponding denominators. Those monthly continuation rates are converted to an annual continuation rate (ACR), in percentage terms:

$$ACR = 1{,}000\ (MCR)^{12}$$

While not shown empirically, it appears that annual continuation rates computed in this way will be sensitive to the distribution of users by duration of use. Given the tendency to discontinue in the early months following acceptance, it is likely that a scenario in which prevalence is growing rapidly would reveal a lower continuation rate than one in which the majority had been using some method of contraception for a longer time. In other words, annual continuation rates computed in this manner may not be entirely comparable over populations. The extent of the bias may be moderate but needs to be explored.

A rough comparison between the rates reported in table 4 by each methodology shows that Laing's continuation rates reported for the Philippines in 1980 do in fact fall consistently below life-table rates reported for the United States and even Mexico.[11] A second comparison can be made between the cross-sectional results for the Philippines in 1980 and life-table continuation rates reported in table 1 from retrospective follow-up surveys of acceptors in 1974 and 1976. Rates derived from Laing's contraceptive-status-calendar method are consistently lower than life-table rates, despite the fact that they refer to a period from four to six years later. Neither of these comparisons is perfect, since differences exist not only in terms of methodology but also, in the first case, in locale, and in the second, in the kind of data used. Even so, the consistently lower continuation rates observed in the calendar-status method merit further investigation, ideally in the form of a life-table analysis of Laing's calendar data.

In the case of Mexico, the rates observed from cross-sectional data in 1979 can be compared with those presented in table 1 using retrospective programme follow-up data about five years earlier. When both sets of data are subjected to the same life-table methodology, the results suggest somewhat higher rates of continuation are obtained from the cross-sectional data. This difference may be attributed to the passage of time (five years) or may reflect the inclusion of non-programme contraceptors.

Potential biases with retrospective data

While retrospective survey data are usually more representative than clinical trials and acceptor follow-up studies, they are not entirely free of bias. For example, the proportion of ever-users who deny having used a method is unknown since it is not backed up by programme records. Secondly, there is a greater tendency for recall lapses—women tend to under-report short intervals of use, as well as miscarriages and abortions, and the extent of those lapses is not easily measured. This section will discuss such potential sources of bias.

Evidence suggests that in an interview situation, respondents are prone to under-report short periods of contraceptive use (Keller and

TABLE 4. TWELVE-MONTH CONTINUATION RATES: REVIEW OF RESULTS BASED ON CROSS-SECTIONAL RETROSPECTIVE SURVEY DATA

Country	*Year*	*Author*	*Sample size*	*Data*
Life table methodology				
Mexico[a]	1979	Keller and others, 1981	4 231	Survey
Bogotá, Colombia	1974	Bailey and others, 1976	1 830	Survey
Mauritius	1985	Wong and others, 1987	3 280	CPS
United States	1970-1973	Vaughan and others, 1977	6 302 intervals	NSFG
United States	1970-1975	Grady and others, 1983	9 797 8 611	NSFG I,II
United States	1973 1976	Hammerslough, 1984	9 797 8 611	NSFG 1973 NSFG 1976
Contraceptive-status calendar				
Philippines	1980	Laing, 1985	4 320	COS

CPS Contraceptive Prevalence Survey
NSFG National Survey of Family Growth
COS Community Outreach Survey

[a] Survey obtained retrospective histories during 1974-1979.

others, 1981), thereby under-estimating the diversity of experience. All retrospective history methods are subject to this bias. An advantage of the current-status method is that it is less affected by the bias, except in so far as short periods of use terminating in pregnancy are under-reported.

In addition, it appears that most of the retrospective recall bias is method-specific. Modern clinical methods are far more reliably recalled than are traditional methods. A review of data from Taiwan Province, India, Britain and the United States suggests that the reliability of reported use of sterilization, IUDs and oral contraceptives was consistently higher than that for rhythm, condoms and other traditional methods (Laing, 1984). Again, it is retrospective-history methods, rather than the current-status method, which are affected by this bias.

Unfortunately, the data provided in such widely available fertility surveys as the WFS do not readily permit the kind of contraceptive histories appropriate for life-table analysis. In some of the surveys, questions are included on current use, length of time using a particular method during the current uninterrupted segment of use or—if the respondent is not currently using contraception but has used it in the past—length of use during the most recent segment of use and reason for discontinuation. Those data can then be pieced together to form a history. Retrospective inquiries of this nature are of course subject to recall-lapse, since—particularly in the case of past users—contraception may have been used a long time before the survey.

Sub-population	Continuation rates							
	Total	IUD	OC	Condom	Barrier/ spermicides	Rhythm	Withdrawal	Injectables
	75	88	67	76[b]				69
		90	91	88[b]				
			64			61		51
Preventer[c]	97	95	94	97	92	98[b]		
Delayer[c]	90	94	90	91	91	89[b]		
	69	79	74	62	54	71		
Preventer[c]	70	80	73	62	58	81		
Delayer[c]	68	77	75	61	51	63		
22-25[d,e]								
Black[d]		89	84	86	84	86		
Non-black		92	89	90	90	90		
		70	42	10		51	43	

[b] Rate includes barrier methods, spermicides, rhythm and withdrawal.
[c] Selected sub-populations by contraceptive intention.
[d] Selected sub-populations by age, income and race.
[e] Y < 10,000.

The availability of a unique set of successive cross-sectional fertility surveys from the Republic of Korea permits an investigation of the consistency of contraceptive-use information, as obtained from both retrospective- and current-status data (Pebley and others, 1986). The results suggest that contraceptive-use data are sensitive to the quality of overall data, and the wording and sequence of questions is important in eliciting accurate retrospective information. Backdated information on current use in 1974, as elicited from the 1976 survey, considerably underestimates use in 1974, as compared with the extent of current use reported in the 1974 survey.[12] The authors suggest that much of the difference may be attributed to variations in the general quality of the two surveys. Some of the difference, nonetheless, may well be attributed to under-reporting of past-use segments in retrospective inquiries.

Evidence regarding the relatively greater accuracy of the calendar approach is presented in a study of contraceptive histories which uses both prospective (via clinic records) and retrospective data from Oxford (Coulter and others, 1986). The study assesses the accuracy of recall of oral contraceptive histories by comparing information derived from an ongoing prospective clinical follow-up survey (the Oxford/FPA cohort study) with retrospective information obtained from one of two types of retrospective surveys—one which included a contraceptive calendar and one that simply included questions on use experiences. According to the prospective clinic records, duration of use for about two-fifths of all

respondents was eight years or more—clearly an unusually long reference period. As a result, the overall levels of agreement between prospective clinic records and retrospective data were moderate, at best, and suggest that retrospective reporting of events in the distant past is likely to be incomplete.

Of interest, in addition, is the extent to which the type of retrospective questionnaire administered contributed to overall agreement between prospective clinic records and retrospective responses. The results indicate that prospective and retrospective information on total duration of and date of last use obtained from respondents subjected to the calendar approach agreed to within six months of each other among 56.2 per cent and 66.7 per cent of respondents, respectively; the corresponding proportions among respondents who did not have the benefit of the calendar were 39.2 per cent and 52.9 per cent. The results suggest then the advantage of the calendar method in minimizing the misreporting of past contraceptive experience.

The extent to which such detailed information can be recalled reliably has been questioned. Laing (1984) argues, however, that while reliability at the individual level may be poor, aggregate estimates are highly reliable; that though monthly-based information is required, lack of reliability on specific details does not introduce much bias as long as information on the number of months of use and on contraceptive use at the time of conception is reliable.

A second potential bias arises when estimates are derived from incomplete contraceptive history data. For example, such data sets as WFS obtain information about only one contraceptive method in the last closed and open birth interval. If additional methods have been used, the resulting bias is not negligible (Goldman and others, 1983). In addition, they do not obtain information on the date of initiation or discontinuation of contraception; therefore, if a method is reported to have been used during any interval, it is assumed to have been used for the entire interval. As a result, only extended failure rates can be reported (Goldman and others, 1983).

Yet another bias results from the under-reporting of abortion. When failure rates are based on survey data, any tendency to under-report unintended pregnancies terminated by abortion will bias failure rates. A study of United States women (Grady and others, 1986) estimates that married women reported only 82 per cent of their abortions. However, failure rates which adjust for this under-reporting are only marginally different from the unadjusted rates. In contrast, for single women, whose reporting is generally estimated to be less accurate, abortion-adjusted failure rates average about 44 per cent higher than the unadjusted rates. It appears then that the extent of the bias varies with the magnitude of under-reporting.

Again, this bias is of greater concern to retrospective-history methods, which rely on the accurate reporting of events. In contrast, the current-status method applies a constant ratio to births to arrive at the total number of pregnancies. A problem with the Bongaarts method, however, is that by adjusting the number of births in order to arrive at the number of conceptions, a constant ratio is applied to both those who have accidental pregnancies and non-contraceptors. In other words, it is implicit that the ratio of conceptions to births is identical among those who have accidental pregnancies and the general population. But women who experi-

ence an unwanted pregnancy may well be more likely to undergo abortions than women who are not using contraception. If that is so, the application of an identical ratio would tend to bias the real failure rate downward.

Finally, biases may arise from the fact that reference periods for analysis vary considerably over studies. For example, certain studies, including those on the United States, examine all intervals of use within a particular time period prior to the study. In contrast, others, such as some of the CPS and WFS studies, concentrate on, at most, one particular segment of use, such as the most recent interval, irrespective of when it occurred. To the extent that the most recent interval may have occurred well in the past and hence require a longer period of recall than a recent time period, it may be hypothesized that the potential for under-reporting of events may be more severe in interval-based reference periods. In the time-based reference period, many segments of use can be included for each woman; experiences of women who switched methods or experienced contraceptive failures and therefore contributed more segments would be more likely to be included in the time-based rather than the interval-based reference period. Both these hypotheses, which need empirical application, suggest higher estimates of failure rates when time-based reference periods are used.

Problems of redundant protection

When contraceptive use overlaps other fertility-inhibiting mechanisms such as amenorrhea or reduced coital frequency, the actual protection afforded by contraception is marginal. The user is at less risk of pregnancy even without contraception, and the resulting estimate of failure may be biased downward. Unfortunately, not much evidence is available on the extent of overlap, and even less on its impact on failure rates.

One problem in estimating the degree of overlap between post-partum amenorrhea and contraception is the difficulty in pinpointing the duration of post-partum amenorrhea (PPA). Protection against pregnancy during this period is not always complete, since, for over 50 per cent of women, ovulation precedes menstruation by two weeks, and hence non-susceptibility effectively ends before the end of post-partum amenorrhea. However, since the first couple of cycles are often anovulatory, the risk of pregnancy before the end of PPA is minimal. In any case, any contraception prior to resumption of menses by more than a couple of weeks is largely redundant. Another problem in assessing the overlap is that certain contraceptives themselves disturb the duration of amenorrhea. For example, use of the oral pill can shorten the duration of amenorrhea or may be associated with spotting, which might be interpreted as onset of menses.[13] In contrast, injectables can induce amenorrhea, and this may be interpreted as prolonged post-partum amenorrhea.

Several recent studies (Millman, 1984; Pebley and others, 1985; Knodel and others, 1985; Ford and others, 1985) have examined the extent of overlap between contraception and lactation or post-partum amenorrhea. There is evidence of a negative relationship between lactation and contraception (Millman, 1984; Knodel and others, 1985; Ford and Labbok,

1985), implying, correspondingly, a negative relationship between post-partum amenorrhea and contraception.

A comparison of patterns of contraceptive use during lactation in 18 less developed countries (Pebley and others, 1985), using WFS and other surveys, shows that the proportion of ever-married non-pregnant women with at least one child who were currently breast-feeding and using contraception ranged from a low of under 10 per cent in Bangladesh, Kenya and Guatemala to over 40 per cent in Costa Rica, Fiji and southern Brazil. At 0-3 months post partum, during which amenorrhea is assumed to be most prevalent, the proportion who were currently lactating and also using contraception ranged from under 10 per cent in seven countries (Bangladesh, Dominican Republic, Guatemala, Jordan, Kenya, Peru and Republic of Korea) to over 20 per cent in another five of the countries observed (Brazil, Costa Rica, Fiji, Panama and Sri Lanka).

Data from the United States (Ford and Labbok, 1987) suggest that the overlap between lactation and contraception in more developed countries may be increasing over time. A comparison of age-adjusted data from 1970 and 1982 among lactating women who had had a birth 4 to 6 months earlier suggests an increasing trend towards early resumption of contraception. In fact, in 1982, by the fourth month post partum, over 86 per cent of lactating women were using some form of contraception.

Of course, overlap between contraception and lactation does not necessarily imply redundant protection; a more accurate measure is the overlap of contraception with post-partum amenorrhea. The extent of that overlap is measured for a number of less developed countries (Millman, 1984; Knodel and others, 1985; Laing, 1984). Millman estimates the extent of redundant use—that is, the proportion of contraceptors who are also amenorrheic, from the data used in the Pebley and others (1985) study referred to above.[14] Her results suggest that a considerable proportion of total contraception can be redundant. The extent of the overlap ranges from 4 per cent in Costa Rica to as much as 38.8 per cent in Bangladesh. Independent studies in at least two other countries have arrived at estimates within that range from more direct data. For example, overlaps of 5 and 15 per cent of current use, respectively, have been reported for Thailand (Knodel and others, 1985) and the Philippines (Laing, 1984).

It is clear that the extent of redundant protection offered by contraception in those cases is not inconsequential. Millman goes on to estimate the impact of the redundant protection on the index of contraception (C_c) (Bongaarts, 1978) at various levels of prevalence and redundant protection. In the case of Indonesia, where a total prevalence rate of 22 per cent is accompanied by low rates of redundant protection, the effect on C_c is minimal. And in the case of Bangladesh, in which redundant use is high but overall prevalence is low, the effect on C_c is similarly unimpressive. Nonetheless, the effect on C_c may be considerable under conditions of relatively high levels of both prevalence and redundant use. With the expansion of programmes which integrate contraception with maternal and child health services, it is possible that contraception will increasingly be offered immediately following delivery, resulting in both more prevalence and more redundant protection.[15]

Even fewer data are available on the links between coital frequency and use failure and effectiveness. Coital frequency is relevant in the assessment of contraceptive failure since higher frequency implies higher risks. There is also evidence which suggests a preference for more effective methods of contraception among couples whose coital frequency is high. For example, a pilot study in Great Britain (Riley and others, 1985) concludes that condom users had lower mean coital rates than users of more effective methods, such as the IUD or oral contraceptives. As far as failure rates are concerned, a study using cross-sectional data from the United States (Jones and others, 1980) shows that high coital frequency (over six times in four weeks) is moderately associated with contraceptive failure among young (under 25) delayers, but the picture among older women and preventers is unclear. The study concludes that variations in coital frequency do not significantly affect failure rates.

It is possible, however, that failure rates for specific methods which are coitus-dependent will be more affected by coital frequency than for contraceptors in general. However, a clinic-based study of failure rates associated with periodic abstinence methods in San Diego (Weeks, 1982) also suggests that the effect is marginal.[16]

There is, then, little conclusive evidence, one way or the other, of the extent of the bias exerted by redundant protection. That there is overlap is clear and that it can be quite extensive is also clear, but empirical evidence on the impact of the overlap on failure rates tends to be fraught thus far with either data problems or insufficient controls.

There is no question, however, that if the proportion of contraceptive use which overlaps with non-susceptible time is high, then an estimate of the inhibiting effect of contraception which assumes that all months of use occurred during periods of susceptibility will be unrealistically high. In order to avoid that bias, it is important to account for such overlap between states. The detailed calendar approaches to data collection (Laing, 1984, 1985; Gaslonde and Carrasco, 1982) are able to extricate periods of overlap and allocate periods of contraception with amenorrhea or abstinence entirely to those states rather than to contraception. While the approach may be more demanding in terms of data input, it is a powerful means of reducing the bias arising from redundant protection and is particularly relevant for much of the less developed world where lactation and abstinence are widespread and contraceptive prevalence expanding.

Conclusion

Conventional approaches to the assessment of contraceptive-use failure and continuation by means of prospective and retrospective clinical trials and acceptor follow-ups have certain limitations. While it is true that intensive follow-up studies with large samples and active follow-up by interviewers can provide relatively sound estimates of failure and continuation, the cost of such studies has limited their number. By and large, as a result, such studies are not representative and are subject to considerable loss to follow-up, such that their results can not necessarily be generalized, even under similar cultural conditions. Also, the trend away from clinic-

based programmes has increasingly limited the relevance of such studies to the general population.

In addition, results are reported based on a variety of different types of rates, occasionally unspecified, which makes them less comparable. By and large, failure rates estimated from follow-up surveys tend to be considerably lower than those reported in population surveys, a finding observed in a recent review (Trussell and Kost, 1987) and corroborated by the few directly comparable data which are presented. Finally, those studies have resulted in a wide range of estimates of failure and continuation rates, making it difficult to make recommendations for method selection.

All of these limitations have pointed to the need to rely on population-based estimates of contraceptive-use failure and continuation. A number of promising new approaches have been developed and are outlined in this paper. While all of the methodologies are designed to be applied to data obtained from fertility surveys, they range from simple to complex, both in terms of their design and in terms of the additional survey data required for their application. Basically, two broad kinds of methodologies have evolved. The first is the retrospective-history method, involving manipulations of contraceptive history data. The second is the current-status method, which involves the manipulations of current-status information from fertility surveys. The sections above have outlined the various methodologies, their results, and some potential sources of bias. This section attempts to point to a few issues for further research which emerge from the overview.

Each of the methodologies has been applied empirically to a limited number of data sets and appears to produce plausible results. There is need, however, to apply each methodology extensively—that is, to a wider number of data sets and to apply various methodologies to a single set of data, in order to arrive at more rigorous conclusions regarding their relative merits.

Of more general concern is the wide range of failure and continuation rates observed both in studies based on clinic and programme acceptors and those based on fertility surveys. There is need to clarify the extent to which the variation arises from purely methodological issues or from real differences between societies or sub-populations within a society.

While retrospective-survey data are clearly more representative than clinical trials and acceptor follow-up studies, they are not entirely free of bias. Two sources of potential bias persist. The first is the recall lapse, particularly the tendency among women to forget periods of use in the past or the dates of use which are reported. While such a bias is of least concern to the Bongaarts current-status method, it is particularly relevant in the case of a methodology such as the Laing contraceptive calendar, which requires a detailed and monthly-based history going back as far as three years. Of interest would be an evaluation of the robustness of these various methodologies to recall differences.

The second area of concern—one which affects the retrospective-history methods in particular—is the tendency to under-report unintended pregnancies which were terminated by miscarriage or abortion. The scarce evidence which is available suggests that severe under-reporting can affect failure rates substantially. Again, it would be interesting to assess the

effect of abortion under-reporting on use failure and effectiveness rates and the ability of each methodology to account for it.

Overlaps between contraceptive use and other fertility-inhibiting factors such as amenorrhea or reduced coital frequency are expected to result in underestimates of failure. The evidence suggests that in scenarios of high contraceptive prevalence accompanied by considerable redundant protection, the effect on the measurement of use-failure rates is not inconsequential, and methodologies need to account for this. In addition, though both the Laing contraceptive-calendar status method and the Gaslonde and Carrasco sexual-activity tables obtain direct information on some overlaps, whether such detailed information can be accurately provided, for a reference period in the past, also needs further investigation.

At initial stages of family planning activities, it is imperative to assess such indicators as the number of contraceptive acceptors and method-specific contraceptive prevalence. As a result, the trend thus far has been to stress the role of contraceptive prevalence, rather than the quality of its use, in evaluating family planning programmes. However, many less developed countries have gone beyond that initial stage to one in which contraception is undertaken by at least a sizeable minority and prevalence often exceeds one third of currently married women in the reproductive ages. At such stages, prevalence is no longer a sufficient measure of a programme's success. Rigorous estimates of the reliability of the method and the continuity of its use become critical elements in the assessment of the impact of contraception on fertility, allowing for better monitoring and evaluation of programme activities, improved effectiveness in meeting the needs of users and, more generally, improved ability of Governments to achieve goals set for fertility. The methodologies discussed in this paper address precisely that issue of developing simple, uniform and representative (population-based) measures of the quality and duration of contraceptive protection.

NOTES

[1] Computed as 100 times the ratio of failures to exposure measured in woman-years, its range is 0-1,200. The maximum of 1,200 would be achieved if all users became pregnant in the first month under observation. The value among young married women under natural fertility conditions is about 250 (Sheps, 1965).

[2] One advantage of follow-up studies of programme acceptors over clinical trials is that they capture failure and continuation under more typical—i.e., less supervised—conditions. Hence, they represent an important source of information. However, the expense of conducting such studies has limited their numbers.

[3] Twelve-month continuation rates range from 51 per 100 users in Zaire (Bertrand and others, 1984) to 75 in Indonesia (Teachman and others, 1979). The range for IUD continuation rates is from 55 to over 90; for oral pills, 30-78; for barrier and spermicide methods, 20-70; for periodic abstinence methods, 23-60 (rates as high as 99 seem less plausible); for injectables, 22-62. Implant continuation rates are consistently higher and less variable, ranging from 77 to 92.

[4] The problem is that as the population becomes partitioned, the sample size in each cell becomes too small for any meaningful results, thus limiting the possible number of control factors.

[5] Trussell and Kost recommend a number of ways of reducing those biases. One, since the sample is not random, it is important for clinical trials to document such acceptor characteristics as age, parity and contraceptive intention. Two, women lost to follow-up should be censored three months prior to the last observation, so that they may be more accurately classified then as continuing.

[6] Standard life-table methodology has been applied to data from a number of retrospective fertility surveys, most extensively to the NSFG surveys conducted in the United States (Trussell and Menken, 1982; Schirm and others, 1982; Grady and others, 1982; 1986; Hammerslough, 1987) but also to data from WFS and other fertility surveys in Flanders (Cliquet and others, 1983; Lodewijckx and Impens, 1987), England and Wales (Bone, 1978), Latin America (Goldman and others, 1983), Mexico (Keller and others, 1981) and Colombia (Bailey and others, 1976). The scope of some studies has been extended to fit proportional-hazards functions to contraceptive failure in order to study demographic and social correlates of failure (see, for example, Trussell and Menken (1982), Schirm and others (1982), Potter and Phillips (1982), Phillips (1982), Grady and others (1986) and Hammerslough (1987)).

[7] In its simplest form, using Potter's notation but omitting loss to follow-up, life-table methodology entails the following (Trussell and Menken, 1980):

N_x	=	number of women continuing use at the beginning of the interval (month x to month $x+1$);
D_{xj}	=	number of terminations during this period due to cause j; one cause, of course, is failure;
T_x	=	the sum of all observed terminations during that interval;
C_x	=	number of continuing users last observed during the month.

Since the known quantities are the number of users at the beginning of the period of observation (N_o), the number of users who discontinued, including both failures and other causes (T_x), the number continuing at the end of the month (C_x), N_x+1 is obtained recursively:

$$N_{x+1} = N_x - T_x - C_x$$

N_x does not actually represent the number of women exposed to the risk of terminating use at the end of the month since women coded as C_x, whose experience is censored due to the initiation of analysis, have only been observed, on average, for half a month. An adjustment is made to remove half a month of observation:

$$N_{x*} = N_x - .5\ (C_x)$$

The conditional probability of failing during the xth month (that is, the interval between x and x+1) is q_x,

$$q_{xj} = D_{sj}/N_{x*};$$

and similarly, the conditional probability of terminating use for any reason during the xth month is:

$$q_x = T_x/N_{x*}$$

Given the conditional probability (q) of terminating use for any reason, the estimated probability of continuing with the method for exactly x months is:

$$t = x-1$$

$$p_x = \Pi(1-q_t)$$

$$t = 0$$

where:

q_x = T_x/N_{x^*} = conditional probability of terminating use;
N_x^* = number of women continuing use at the beginning of the interval (month x to month $x+1$), adjusted;
T_x = the sum of all observed terminations during this interval.

[8] In order to calculate extended-use effectiveness, u would be redefined as the proportion of women who ever used a method during the interval, even if use was discontinued at the time of conception; correspondingly, p would include all the resulting pregnancies. In the case of method-specific rates, u and p would refer respectively to users of and births to women using a particular method.

[9] For example, in the case of oral contraceptives, the range of rates extends from 2 to 8 for life-table and sexual-activity-table analysis, to between 8 and 13 in the case of the current-status method and as much as 19 in the case of the contraceptive-calendar-status method. Similar differences may be observed in the case of condoms, barrier and periodic abstinence methods and withdrawal.

[10] The two life-table estimates of failure for Columbia are not comparable. The Goldman and others (1983) estimates are drawn from a national sample in 1976 while Bailey and others (1976) report rates for an urban sample a few years earlier. More important, the former rates are extended, the latter net; WFS rates are then expected to be higher.

[11] For IUD continuation, where both sets of rates are most similar, the Philippines report a 12-month continuation rate of 70, compared with 88.5 for Mexico and 78.6-95.1 for the United States.

[12] Current use at ages 20-29 in 1974 was reported as 23.8 per cent in the 1974 survey and 15.1 per cent by backdating from the 1976 survey; and 47.6 per cent and 41.9 per cent, respectively, at ages 30-39. The differences are attributed to differences in the quality of the surveys. The authors advise greater attention to such issues as interview-training and the wording and sequence of pertinent questions.

[13] Menstruation in all 52 lactating oral pill users in India (Prema, 1982) was resumed within 2 months of use.

[14] Estimates were obtained by applying amenorrhea schedules specific to women who are or are not breast-feeding by duration post-partum, obtained from a WHO study of breast-feeding in certain less developed countries. Rates of redundant protection, defined as the proportion of sample women using contraception during PPA, are low (1-5 per cent) in all countries. Two estimates of the extent of redundant use are presented, from the data used in the Pebley and others (1985) study referred to above. The estimates include the proportion of sample women estimated to be using contraception during post-partum amenorrhea and the proportion of contraceptors who are also amenorrheic.

[15] In many cases already, IUDs are inserted immediately following delivery, thus providing some redundant protection.

[16] In fact, Pearl pregnancy rates tend to be slightly higher (19.8) among couples whose reported coital frequency was under six times per month than among those whose frequency exceeded six (16.3). The extent to which simultaneous use of a barrier method by high-frequency couples may have contributed to this unexpected finding, however, is not explored.

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THE DEMOGRAPHICS OF MACRO-ECONOMIC-DEMOGRAPHIC MODELS*

*Richard E. Bilsborrow***

SUMMARY

A number of macro-economic–demographic models have been created for developing countries during the decades of the 1970s and 1980s. Such models purport to simulate relationships between demographic variables and the process of socio-economic development in the particular country, with the dual purposes of enhancing our knowledge of the process in particular settings and, by examining alternative scenarios, providing useful information to policy makers on the selection of demographic and economic policies to enhance economic development and improve human welfare.

This paper first reviews the antecedents and then focuses on assessing the demographic functions (fertility, mortality and internal migration rates) used in the two families of models which have had perhaps the largest number of applications in developing countries—the Bachue models, originating at the International Labour Office (Geneva), and the ESCAP models, originating at the Economic and Social Commission for Asia and the Pacific (Bangkok). Each has been applied, with significant variations, in at least five countries—the former in the 1970s to early 1980s, and the latter during the 1980s.

Economic-demographic functions are defined as endogenous (and substantively meaningful, from the points of view of this paper) whenever there is an effect of economic growth or change in economic structure on the particular demographic function. The bulk of this paper assesses the realism and endogeneity of the fertility, mortality and migration functions used in the Bachue and ESCAP models, noting, where possible, both the apparent or *prima facie* behavioural relationships and those that are actually important in the dynamic simulation. Shortcomings are described, including the lack of governmental expenditure functions with effects on demographic variables.

*This paper has evolved over a long period of time, beginning with the 1973 South-East Asia Development Advisory Group meeting on macro-economic models (sponsored by the Asia Society, New York), a 1979 meeting sponsored by the Population Division of the United Nations Secretariat and UNFPA in Geneva, and finally a recent CELADE Technical Seminar on methods for incorporating demographic impacts into planning through the use of microcomputers, held at Santiago de Chile in 1987. I am grateful to David Horlacher, *Population Bulletin* referees, and especially Richard Anker for helpful suggestions. None shares my responsibility for any shortcomings.

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The paper concludes more positively, noting areas of congruence and appealing endogenous relationships and functional forms specified in certain country models. It also suggests further development of, on the one hand, both simpler and more realistic planning models (focusing on particular behavioural relationships or sectors of importance to the country), which will be easier for country planners to understand and hence use, and, on the other hand, more complex research models aimed at enhancing our understanding of fundamental, dynamic relationships between economic factors, governmental policies and fertility, mortality and migration rates during the course of socio-economic change.

Introduction

The purpose of this paper is to assess the state of the art regarding economic-demographic models of the interrelationships between population and socio-economic development in low-income countries. The assessment focuses on demographic functions and on methodological rather than substantive issues, to help identify where different or modified functions and approaches would be both feasible and methodologically superior. Recommendations are made with a view to improving the utility of the models for governmental planners.

It must be recognized that any effort such as this is individualistic and biased—biased by personal value judgments (which Myrdal (1961) notes are inevitable in all economic models and research), experience in low-income countries, and areas of past and present research.

Purpose and evolution of macro-economic-demographic models

Models are attempts to simplify reality, to capture or focus on key aspects of the real world so as to assist us in understanding it better. Models are particularly important in the social sciences because of the complexities of interrelations and feedbacks in human systems. We may thus distinguish mental models, or models of reality that each of us has in his head, which may be extraordinarily complex, and mathematical models, or models that are expressed in systems of equations and that force the identification of all relationships and functions otherwise implicit or buried in mental models. The development of mathematical models has been enormously facilitated—and indeed stimulated—by advances in computer hardware and software in the past two decades, advances which, if anything, appear to be accelerating. These advances make it possible to develop increasingly more complex and realistic models. The forces of history and technological change swamp arguments that such models cannot be useful because they are not sufficiently accurate depictions of reality. Thus, it is important to identify what we have learned from the development of these models to date and what steps might be useful in the near future.

Since there are now many people who have worked on the development of country and global models of one kind or another, the comments here are made tongue-in-cheek. Although I am not a professional modeller,

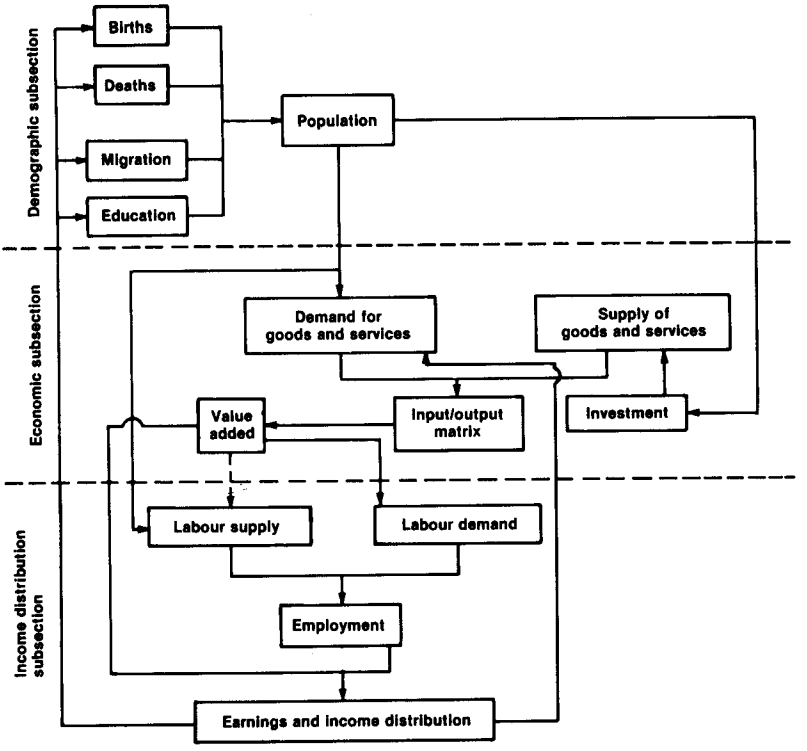
I have been on the fringe of the development of macro-economic–demographic models since 1972. I therefore find it simultaneously refreshing and distressing to note how little has changed. The debates about the lack of sufficient data, inadequate empirical bases for behavioural functions, "black boxes" and model complexity, lack of model dynamics or realistic equilibrium conditions etc. continue, despite considerable advances in the development of particular models. First, let us consider the origins of the contemporary generation of macro-economic–demographic models.

There is a long, deep-rooted tradition for economists to be interested in the relationships between population and the economy, dating back at least to the time of the Malthusian/Ricardian classical theory of economic development. In their theory, any factor that caused production to rise would cause fertility and population growth to increase in response. This endogeneity of population was then ignored for about a century. During that time, neoclassical economics flourished, considering only the supply side, in which population (and labour) inputs were assumed to be exogenous. But the neglect of population was not inevitable in the neoclassical model, as Coale and Hoover (1958) later illustrated. Their model, and subsequent early models of GE-TEMPO, were based upon two driving equations, a classical production function for output (usually Cobb/Douglas) and a savings function that depends inversely on population size. A major purpose of those models was to stimulate scholars and Governments in developing countries to be concerned about accelerating rates of population growth after the Second World War. The PLATO and RAPID models were of the same genre. In fact, the A in RAPID stands for "awareness."

The second generation of TEMPO modelers recognized the original purpose and limitations of the TEMPO-I model (Cole and Brown, 1975). In order to confront some of the criticisms and move towards a model that would be of potential use to planners in developing countries, TEMPO-II was developed (McFarland and others, 1973). While still strictly a supply-side model using a neoclassical production function in the modern sector,[1] it introduced two important improvements which have been incorporated to varying degrees in most subsequent country-wide economic-demographic models. First, it was expanded to a two-sector model, to embody the theory of economic dualism and include internal migration as an endogenous feature of the development process. Secondly, it included a public sector to facilitate the study of the effects of changes in governmental policies. But the model still treated fertility and mortality as completely exogenous, with neither influenced by the rate of economic growth. Only migration was endogenous. Higher rates of population growth resulted in increased demand for various governmental services, but only the effect on education expenditures was incorporated into TEMPO-II. A simple, linear, exogenous family-planning expenditures function related family planning programme expenditures to births averted and, therefore, to fertility. That was apparently the first time such a function was explicitly incorporated into a macro-economic–demographic model—an important step.

A detailed description of the characteristics of the more complex country-level models, such as those in the Bachue family discussed below, is beyond the scope of this paper. The figure, from Bachue-International

Figure. Main relationships in Bachue



(Moreland, 1984, p. 11), illustrates the general structure of the Bachue models, which have three subsystems. The demographic subsystem includes behavioural functions or accounting relationships to generate births, deaths, migration and the population distribution by age, sex, location and education. The economic subsystem generates final demand, based on population and level of income; the latter results from exogenous assumptions about output levels, such as from a national development plan. Thus, the Bachue models are demand-driven: an input-output matrix converts demand to value-added, labour demand and employment, and hence income distribution, which feeds back into the demographic subsystem. The ESCAP models are generally similar in their complexity, subsystems and population disaggregation, though they vary in economic structure from simpler two-sector models to analytically complex so-called computable general equilibrium models (see below). While the Bachue and ESCAP models are sophisticated and involve more realistic country applications than TEMPO or other earlier models, useful two-sector country models could be created simply using models such as TEMPO-II as a point of departure.[2]

Much of the debate regarding the utility of present models[3] relates more to philosophical or taste issues than to questions of fact or technical

relationships; for example, are the models intended to make a point or to attempt to describe reality; are they intended for policy/planning or research/academic purposes; what is the time horizon (the longer, the greater the interrelations between population change and socio-economic change)? Failure to distinguish the issues has led to much talking at cross-purposes, with experts asking whether the data base is adequate, whether important structural or behavioural relationships are omitted, whether the model is too complex or too simple, and whether the model is useful for governmental planning (see Arthur and McNicoll, 1975; Rodgers, Wery and Hopkins, 1976; United Nations, 1981). I believe both the more simple and the more complex models can be useful, depending on the context, which will be further discussed below.

The different types of models[4] may be classified as:

(*a*) analytical (Bachue family TEMPO II);

(*b*) crisis (Coale-Hoover, TEMPO-I, RAPID, "Limits to growth" models, including World 3, the World Integrated Model of Mesarovic and Pestel, and the Global 2000 Report of the United States Council on Environmental Quality in 1980);

(*c*) anti-crisis (Clark, 1967; Simon, 1977);

(*d*) normative (Bariloche model—cf. Herrera and others, 1976).

There are many other models in the literature commonly referred to (especially by their authors) as "economic-demographic" models, which really do not qualify. They include a wide range of economic and econometric models in the academic literature as well as the United Nations model of Leontief (1977). Those models typically include population variables in the denominator and have all demographic parameters exogenous. Properly defined, "economic-demographic models" must have at least one of the three demographic parameters (fertility, mortality or migration) endogenous—that is, influenced in some fashion by the process of socio-economic development. Thus, an economic model which treats population as endogenous must include population growth and/or distribution change as a result of a change in the rate of economic growth or change in economic structure.

If a model qualifies as an economic-demographic model, it is important to consider how the demographic variables are treated in it. This paper is primarily concerned with an evaluation of the demographic functions and related characteristics of two families of models developed for developing countries over the past 15 years—the Bachue models and the ESCAP models. (See the figure for relationships in Bachue models.) Each of the models is intended to be an analytical model (in the sense given above), not a forecasting model. They are intended to help us understand relationships between variables of interest over several decades.

The two families include the "best" and most complex economic-demographic models developed for low-income countries, but they do have important and remediable shortcomings. The discussion below thus assesses the demographic functions in the Bachue models for Brazil, Kenya, the Philippines and Yugoslavia; "Bachue-International"; and a Bachue "basic needs" model (for Colombia). It then considers the recent ESCAP models for Indonesia, Malaysia, the Philippines, the Republic of Korea and Thailand.

I begin with the functions used for the determinants of fertility, followed by those specified for mortality and internal migration. The paper will consider only behavioural functions for the three basic demographic variables—fertility, mortality and (internal) migration. Thus, some closely related functions are omitted—labour-force participation rates, school enrolment or educational attainment, and food supply and consumption (nutrition). Moreover, it is concerned only with the determinants of demographic rates and not with their consequences (recent reviews of the latter include Ahlburg, 1984; the 1986 National Academy of Sciences (NAS) report; and Kelley, 1987). Finally, it is far easier to criticize these models than to select and estimate the myriad relationships necessary to constitute a workable one that behaves reasonably.

Structural weaknesses in some existing country-wide economic-demographic models

Fertility functions

The fertility functions are, in general, the greatest weakness in most existing country-wide economic-demographic models, including those in the Bachue and ESCAP families. Long-run fertility changes during the course of modernization are simply too important to be ignored, yet that is the escape some models have chosen. More common is the use of unrealistic fertility functions estimated from international cross-sectional data, which hardly does justice to the different circumstances in each country. Those defects are disturbing for at least three reasons:

(*a*) fertility—plus changes in fertility rates—is the major determinant of population growth and its age distribution (Coale, 1972), both of which have important ramifications in economic-demographic models;

(*b*) there exists a far larger and generally more consistent body of literature on the determinants of fertility than on the determinants of the other two main demographic variables (mortality and migration), so that one would expect reasonable fertility functions to be sought and included in economic-demographic models;

(*c*) since most of the models purport to be useful for governmental planning, and since there is a growing body of literature attesting to the influence of policy variables on fertility, the incorporation of appropriate fertility functions which embody policy parameters would appear a *sine qua non* of economic-demographic models. Yet we shall see that this has been observed more in the breach than in the observance.

I shall briefly review the fertility functions in the Bachue models, beginning with Bachue-Philippines, and then turn to the more recent ESCAP models.

The Bachue-Philippines model (Rodgers and others, 1978) is very impressive in many ways, especially in terms of its comprehensive scope and its being the first pioneering, large-scale economic-demographic model for a developing country. Nevertheless, its behavioural function for fertility is a major substantive weakness. The authors investigated early household-survey data in the Philippines but found nothing systematically related to fertility, so they used a function based upon a single-equation

multiple regression for 47 countries.[5] Their function (see table 1) was GRR = 4.67 − .006 FLFPR + .016 (percentage of adults illiterate) − .045 e_0 (life expectancy at birth) + .006 (percentage of labour force in agriculture). Only the coefficient for e_0 was statistically significant, and "because of the small coefficients associated with [the other two variables], most of the variation of the GRR is associated with changes in literacy rates and life expectancy" (Rodgers and others, 1978, p. 212). In fact, this is gratuitous: literacy has virtually no effect.[6] Two other serious problems with the function are the huge size of the mortality effect and the lack of a variable to capture any effects of a family planning programme. I briefly consider those problems below.

First, a non-effect of education is contrary to the literature (even that existing 15 years ago) about the effects of education on fertility, particularly in a long-run, time-series framework.[7] Even if no significant negative statistical relationship was observed between fertility and women's education from a particular Philippine survey data set, at least an implicit one based on cross-tabulations of fertility by education could easily have been used.[8] Then fertility would more realistically decline over time as women become redistributed into higher education groups, following planned governmental policies. In the worst of cases, a fertility function estimated from a survey in a neighboring country (with a negative education coefficient) would have been preferable. In any case, the function should be estimated for *women's* education, not for all adults or for the unreliable literate/illiterate breakdown used in the international cross-section.[9]

A second problem is the unrealistically large effect of mortality on fertility,[10] and the use of e_0 rather than the theoretically preferred IMR. This is particularly important given the high rate of (exogenous) real income growth assumed in Bachue-Philippines (7 per cent in the reference run), combined with the strong, endogenous effect of income (growth) on mortality (decline), embodied in the mortality function (discussed below). Therefore, in the model, (exogenous) income growth in itself causes the observed significant decline in fertility, from CBR = 44 in the base year (1965) to CBR = 29 in the year 2000. The elasticity of fertility (GRR) with respect to infant mortality implied by the Bachue-Philippines function is .394,[11] which is at least double that usually encountered (e.g., .20, derived from a reliable study based on survey data in Taiwan Province).[12]

A third defect in the fertility function—the lack of a term for family planning—is in one sense understandable, since at the time of the authors' work in the early 1970s, the only developing countries that were known to have declining fertility were either (or both) small islands or populated largely by Chinese (Coale, 1974); there was little official family-planning programme activity in the Philippines; and knowledge about an appropriate family-planning impact function was inadequate. In fact, the authors considered a simulated effect of an exogenous family-planning programme on lowering the CBR by an additional 6 points over 35 years (beyond the decline of 15 points, presumably generated by exogenous economic growth) as "implausible" (see below). This has turned out to be an unfortunate prediction. There is now evidence of fertility declines of that magnitude or greater in many developing countries starting in the 1970s alone, and that family-planning programmes have usually contributed to those declines.[13] We shall see that the particular fertility function used seriously

TABLE 1. CHARACTERISTICS OF FERTILITY FUNCTIONS IN SOME MACROECONOMIC-DEMOGRAPHIC MODELS

	Bachue-Philippines	*Bachue-Kenya*	*Bachue-International*	*Bachue-Colombia*	*ESCAP-Indonesia*	*ESCAP-Malaysia*	*ESCAP-Thailand*	*ESCAP-Philippines*
Measurement of fertility.....	GRR	Births	Overall fertility	GFR	TFR	ASFRs	TFR	GMFR
Data estimation based on	Cross-section of 47 countries	Cross-section of 39 districts and 1861 households	Constructed of 25 countries	Constructed time-series for 1960-1975, based on 1976 data	Constructed time-series from 1971	Constructed time-series for 1960-1980	Cross-section of 72 provinces	Constructed time-series for 1957-1977
Explanatory variables								
Education	Adult illiteracy	Percentage of females with primary or secondary education	Adult illiteracy	Adult illiteracy	Overall illiterate; percentage of adults with jr. high + education		Percentage of population with secondary + education	
Female economic activity.....	Female LFPR		Female LFPR	Female LFPR				
Income.....		Y/Population (R)	Y/Population		Y/Population	Y/Population	Y/Population	$\frac{\text{Personal income}}{\text{Population}}$
Mortality	e_0	$1-{}_3q_0$	Female e_0	IMR		$\frac{\text{Doctors}}{\text{Population}}$		IMR
Economic structure.....	Percentage of LF in agriculture							

Population distribution.....	Separate urban/ rural functions			Separate urban/ rural functions	
Family planning.....		Married women per obstetrician/gynecologist		Government outlays on FP/ Population	
Other.....	Percentage of adults sterile; percentage of female migrants (U)	Percentage Y of lower 40%	Percentage of females 15-19	Age at first marriage	Relative price of food

NOTES:

GFR	Gross fertility rate
GRR	Gross reproduction rate
TFR	Total fertility rate
ASFR	Age-specific fertility rate
GMFR	General marital fertility rate
ER	Enrolment rate
LFPR	Labour-force participation rate (FLFPR = female)
Y	Income
e_0	Life expectation at birth in years
$1-{}_3q_0$	Probability of survival to age 3
IMR	Infant mortality rate
U/R	Urban/rural
FP	Family planning

prejudices the major demographic policy conclusions reached in Bachue-Philippines.

Of course, we must not be too critical of the fertility function in Bachue-Philippines, since it was developed in the early 1970s, before the World Fertility Survey and associated research on the determinants of fertility in developing countries, including the Philippines, had been carried out. Later Bachue models did incorporate some improvements, notably Bachue-Kenya (Anker and Knowles, 1983), which is partly based on a household survey implemented to collect information to estimate behavioural parameters. They then estimated a micro fertility function based on the survey data, as well as a macro or district-level fertility function. In the latter, fertility rates across districts were found to be positively related to male literacy and negatively related to the secondary-school enrolment rate, percentage urban and the percentage of adults sterile (reflecting the high level of sterility in Kenya, varying from 8 to 15 per cent across districts). One could quibble with the variables included and their measurement, and problems were encountered (common in macro functions) with multicollinearity, but let us move on towards the function actually used in the simulation.

First, in the separately estimated micro fertility function, the number of children ever-born per woman aged 15-49 was found positively related to husband's education, land, educational expectations for children (rural areas only) and own-child mortality experience, and negatively related to the woman's education, absences of husband, whether in polygamous marriage and whether breast-feeding for less than six months. All signs were in the expected direction except for educational expectations for children (which was then omitted) and breast-feeding. However, the authors noted that the micro function was too complex for use in the Bachue model, since some of its variables were not available at the district level (e.g., lactation, polygamy, husband's absences), and others were not statistically significant. Therefore, the actual function used is as indicated in table 1. For example, the rural function is:

$$\begin{aligned}\text{Births} = \text{Constant} &- .44\ (\text{proportion of women with primary education}) \\ &- 1.88\ (\text{proportion of women with secondary+ education}) \\ &+ .32\ \text{Y/Pop.}\ (\text{income per capita}) \\ &+ .98\ [1/1 - {}_3q_0] - .04\ (\text{proportion of women 40-49 childless}).\end{aligned}$$

While this is necessarily a macro function for the macro simulation, it borrowed extensively from the results of prior estimates of urban and rural micro functions, based generally on the survey of 1,861 households (married women)—1,587 rural and 274 urban. For example, the micro function revealed non-linearity in the effects of education, woman's own mortality experience (for which there is considerable support in the literature), and differences between urban and rural areas. The final result is two functions (one for urban and one for rural) relating the total number of live births (subsequently distributed across ages; a TFR would have been more appropriate) to the proportions of women with completed primary or some secondary education (versus none in the omitted group; note that the effect

of secondary education is greater, as desired), infant/child mortality and proportion of ever-married women aged 40-49 childless. The proportion childless is in turn a (negative) function of the same two female education variables. In urban areas, the proportion of women 15-49 who are migrants is also included to capture their higher fertility. In the rural function, household income per adult is added, with the expected positive relation intended to capture the combined effects of husband's education and quality-adjusted land in the district, both found significant in the earlier micro function. The authors did not want to include husband's education directly since it was expected to rise much faster than income—as has subsequently proved to be the case—and would imply unrealistic positive pressures on fertility over time. The coefficients used in the macro simulation are borrowed directly from the micro estimates except for income and sterility, which drew on the macro function. But one wonders why income was not included in the urban fertility function, as it was in the rural. Regarding the woman's own education, it is not clear why achieving primary education in urban areas would raise fertility, while the usual negative effects are observed in rural areas. And while the changes in fertility associated with improvements in child survival can be shown to be small and plausible, it is not clear why they should be so much smaller in rural areas.

Finally, regarding potentially important missing variables in the initial estimation of the micro functions, woman's work away from home and whether she had visited a family-planning clinic in the previous two years were both tried and their results found unsatisfactory. Since there has been some subsequent increase in family planning in Kenya (current users are over 6 per cent of fecund married women), a family planning variable would probably now be statistically significant and worth including in a long-run simulation from the 1980s onward. While the process of estimating both macro and micro functions helped immeasurably in understanding fertility determinants in Kenya, the legitimacy of simply selectively combining certain coefficients from each may be questioned. This illustrates that model-building is still as much an art as a science and, indeed, statistically estimated significant coefficients are not always sensible to use in a long-run simulation. In the case of fertility, some subjective consideration of factors generally involved in the demographic transition is appropriate.

In terms of model dynamics, the authors note that during the first half of the simulation period, increases in education and urbanization and reductions in mortality have effects on reducing fertility in Bachue-Kenya which are fully counter-balanced by the effects of reductions in sterility and increases in rural incomes. As a result, the entire process of socio-economic change results in little decline in fertility over the 30-year projection period. Part of the problem also appears to be that the education effect on fertility is extremely small and basically limited to higher levels of education, which few women attain during the postulated 30-year scenario. While that seems unrealistic—because percentage increases in the former three factors seem likely to be larger than those in the latter—in fact little decline in fertility has taken place in Kenya to date.

Despite the above comments, the fertility function in Bachue-Kenya appears the most plausible of the four original country-wide Bachue models. But Bachue-Yugoslavia (Macura and others, 1977; Macura and

Popovic, 1984) does include a fertility function with a sort of family-planning programme variable, although only a crude proxy. Using the areal total fertility rate as the dependent variable, one of the independent variables was the number of married women per doctor specializing in obstetrics or gynecology, used as a proxy for the availability of family planning services across areas. It should be noted that Bachue-Yugoslavia, like Bachue-Philippines, includes modeling of age at marriage, but uses the complex "triple exponential" Coale marriage function (Coale, 1971). Unfortunately, actual empirical estimates are not yet published. Finally, with respect to the fertility function in Bachue-Brazil, there is little to say, since, like Bachue-Philippines, it is based on international cross-sectional data, with fertility a function of the percentage of males illiterate, percentage of the labour force in secondary sector, and percentage of women aged 15-19 (Braganca and others, 1980). The variables in those fertility functions are of little use, as should have been clear from the substantial literature existing when that more recent Bachue model was developed.

In considering the Bachue-International model (Moreland, 1984), we should bear in mind that while it followed the basic construction of the four earlier Bachue country models, it had several different purposes, resulting in part from criticisms of the former. Those related to the complexity and size of the former ("black boxes", cf. Arthur and McNicoll, 1975), their rapacious data requirements—usually difficult to meet in developing countries—and their being developed largely by expatriate experts. Moreland's model is therefore simpler[14] and is based on international cross-sectional data, with the explicit recommendation that, in any given country application, a country could plug in its own initial values and substitute a function whenever it had data to estimate it.[15] Because of its completeness and simplicity, it is also intended as a training model, useful in teaching economic-demographic interrelationships, particularly in feedbacks and indirect effects.

In appraising the demographic functions of Bachue-International, one must thus bear in mind its purpose of serving as a framework which can be modified by countries to create usable country-level models for policy simulation and planning. But how can particular functions or coefficients be changed without changing others in the overall structure of the model? (See the discussion of model dynamics of Bachue-Philippines and Bachue-Colombia elsewhere in this paper.) I also question the value of coefficients estimated from international cross-sectional data, as noted above regarding Bachue-Philippines. Indeed, not even the same countries are included in the estimation of the fertility and mortality functions in Bachue-International. Nevertheless, I proceed below to evaluate its demographic functions along the same lines as for the other models.

With respect to its fertility function, it contains a number of the potentially important independent variables (table 1). The equation estimated from a cross-section of 25 unspecified countries is as follows:

$$FR = 5.10 + .12 \text{ Illit.} - .21 \text{ FLFPR} + .43\, e_0 - .25 \frac{\text{Y}}{\text{Pop.}} - .24 \text{ (\% Y of lower 40\%)}.$$

The measurement of FR, total births to total population 15-44, is neither customary nor necessary. At a minimum, the *female* population 15-44 (or 15-49) should have been used, which would have made it the GFR (see table 1 abbreviations). Moreover, the results for the independent variables are weak: the only statistically significant variables are female labour-force participation rate and income per capita, but the sign of the latter and the insignificant income distribution variable are not consistent with economic theory. Perhaps they are interpreted as reflecting the general process of modernization and hence omitted variables?[16] The coefficients of illiteracy (percentage of adults illiterate) and female labour-force participation rate have the expected signs, and that of the latter is significant; but the sign of the coefficient for e_0 is evidently incorrect and its size so huge that, in any simulation, it will tend to dominate other effects. The simulation of fertility is thus seriously impaired, with projected declines in mortality causing fertility to *rise*, subverting the effects of changes in the other variables on fertility over time.

A secondary issue, but one which arises repeatedly with some other Bachue and the ESCAP functions below, is the assumption that urban fertility is a constant proportion of rural fertility throughout the projection period. This is unrealistic and precludes urban and rural fertility from changing in different ways in the course of economic development, or in response to governmental investment allocation, health or family-planning policies. Moreover, the explanatory variables may have different effects on rural and urban fertility. For example, a number of studies have found the effects on fertility of female labour-force participation and education to be quite different in urban and rural areas in developing countries.

The last Bachue fertility function reviewed is that of Banguero's "basic needs" model (1981) for Colombia, developed in collaboration with M. Hopkins of the ILO (table 1). All three independent variables are lagged, which is surely appropriate for the IMR (infant mortality rate). The equation is estimated, as are others in the Banguero model, from time-series data prepared by interpolating between various census and survey data points. Durbin-Watson statistics (which test for auto-correlation in time-series data) are appropriately presented but not discussed, nor is the desirability of controlling for auto-correlation. Signs of the coefficients for illiteracy and mortality are correct, and both have highly significant *t*-statistics, but illiteracy is a crude measure of education. It is preferable to use female educational attainment, measured by mean years of education or percentages with at least some specified level (e.g., primary completed, secondary-plus). Since the effect of female labour-force participation is not statistically significant and its coefficient is quite small, it does not play a significant role in the process of fertility decline in the model. The model also assumes a fixed ratio of rural-to-urban fertility over time, which recognizes fertility differences across space but does not allow the estimation of different coefficients.

It is interesting to trace through the dynamics of fertility in Banguero's model. Fertility is projected in the main reference run as declining from a TFR of 4.7 in 1980 to 2.0 in the year 2000, which implies an acceleration in the already substantial rate of decline in the past. The annual rate of decrease in 1970-1980 is noted by the author as having been 2.2 per cent, while an acceleration to 3.5 per cent per year is expected

during the projection period 1980-2000—and this without any explicit family-planning function! This may also be inconsistent with current experience in most of those developing countries that experienced large fertility declines in the 1960s and 1970s but now appear to be stabilizing at TFRs of 3 or more (e.g., Costa Rica, Republic of Korea).

There are two main reasons for the rapid fertility decline in Bachue-Colombia. The illiteracy rate, which has a significant estimated effect on fertility, is projected to decline dramatically from 15 in 1980 to 5 in 2000, at a rate of 4.8 per cent per year (versus 3.8 per cent in the decade 1970-1980). Such a decline seems unrealistic without a substantial increase in governmental investment in education, which is not specified in the model. Furthermore, the IMR is projected to decline from 61 in 1980 to 41 in 2000. While such a decline is not implausible, the mortality function does not contain a governmental intervention parameter to justify it.

We continue the assessment of the fertility functions in economic-demographic models with the functions used in a number of recent ESCAP models (in 1983-1986). We shall see that most of the problems noted above in the Bachue models also plague the ESCAP models. We begin with the two models for Indonesia and the Republic of Korea (ESCAP, 1983) and follow with the three for Malaysia, the Philippines and Thailand (ESCAP, 1989).

I begin with the Sigit (1983) model for Indonesia. As with the other ESCAP fertility functions, it contains several interesting, as well as disappointing, aspects. First, fertility is measured by the TFR, which is fine, and is specified as a negative function of income and two education variables (table 1). Elasticities estimated from time-series data were $-.12$ (income), $-.18$ and $-.31$ (education), but the t-test for the regression coefficient is greater than 1.1 only for the last of the three. The statistical results are thus quite weak. The author also provides no rationale for expecting a negative effect of income per capita. Most economists expect a positive relationship when other aspects of modernization are adequately controlled for (which is not the case here with only education included). Regarding education, note that the omitted (dummy) group is the percentage of the population with primary-school education; thus, Sigit expects increased primary-school education to raise fertility over time, and increased junior high education and beyond to reduce it. Such an inverted U shape has often been observed, particularly in Asian populations (e.g., United Nations, 1985, chap. II). The dynamics of such a function is that, in the earlier stages of development, as more people receive a primary-school education, fertility tends to rise, but as modernization proceeds and a larger proportion attain junior-high-school education or beyond, fertility falls.

There are serious problems with such an extremely simple fertility function, which captures so little of the important aspects of modernization or population policy. First, in addition to variables such as infant mortality and women's employment, one would surely expect a family-planning variable to be included. A vast amount of research has been directed at attempting to explain why, in fact, fertility has declined so dramatically in the last decade or so in Indonesia despite rather limited economic growth and modernization. This research has attempted to explain why family

planning programmes appeared to have such a substantial impact in many rural areas. Secondly, Sigit's model includes rather remarkable assumptions regarding investment and future economic growth in Indonesia: GDP is assumed to grow at an annual rate of 9.6 per cent in the first five-year period of the simulation (1980-1985), rising continuously to 14.2 per cent by the period 2006-2010 (Sigit, 1983, p. 37). Such a huge increase in economic growth, inconsistent with the past, will lead to a substantial further endogenous decline in fertility through the postulated fertility function, just as in Bachue-Philippines. Such an effect is implausible, at least without explicitly taking into account other aspects of modernization and the expansion of family-planning programmes. Thirdly, the data used for the estimation process are said to be taken from the 1971 census and the 1976 Intercensal Population Survey, with, presumably, extrapolations and interpolations to develop a time-series for 1960-1979. A simple time-series regression is then run, with no discussion of statistical problems (e.g., auto-correlation) or defense of such data manufacturing.

As weak as it is, the fertility function in Sigit at least embodies some endogeneity. The function used in the other ESCAP (1983) model for a developing economy (Republic of Korea) is strictly exogenous. Koo (1983) states that since "no estimates are readily available about the impact of government inputs on the fertility of Korean women" (Koo, p. 59)—presumably referring to family-planning inputs/expenditures—then fertility is estimated as a simple function of time and percentage urban. Both coefficients are highly significant, and it is laudable to use a function which takes into account percentage urban, though I would prefer to do it with separate fertility functions, for reasons noted above. One other positive aspect is the author's using ln (TFR-2) to represent the dependent variable. This ensures a floor-level for the TFR of 2.0, which seems plausible in a long-run simulation model for a country such as the Republic of Korea: TFR could otherwise fall too low during the projection period.

I now continue with the fertility functions in the three more recent ESCAP models, beginning with Fong (1989) for Malaysia, which has separate fertility functions for rural and urban areas and different ethnic groups. Fong uses age-specific fertility rates as the dependent variable and estimates each as a function of variables indicated in table 1. No hypotheses are given regarding expected signs of relationships, nor are units or means indicated for any explanatory variables, impairing evaluation of their relative importance through the calculation of elasticities or standardized regression or Beta coefficients. Regarding the variables included, it is laudatory to include potential policy variables, such as doctors per person and governmental expenditures on fertility planning per capita, but it is not clear *a priori* what sign is expected for the former.

Nevertheless, the results for most variables are statistically significant in both rural and urban areas (ESCAP, 1989, table 3.2). First, age at first marriage (estimated as a prior function of income per capita and the female secondary-school enrolment rate, with both highly significant) is significant in the fertility functions and has the *a priori* correct negative sign for all four younger age groups in both areas. The author justifies excluding age at marriage from the three older age groups (35-49) because of the small proportion of single women. But that is not the issue. It should be included for them for the same reason it is included for younger

women—a shorter exposure period leads to lower fertility. This would improve the modelling of the variable in the fertility function.

The second variable with strong, appropriate effects is that of governmental expenditures on family planning, though there is no indication of exactly what expenditures, when they occurred, lags in impact and data sources. And why not include estimated private expenditures? Nevertheless, regarding the statistical effects, virtually all 14 coefficients (seven age groups × 2 areas) are significant, with the coefficients varying from −.26 to −.41. The larger coefficients in rural areas also have a nice interpretation: "urban households already had their own networks for FP services, and hence were not as dependent on the government for FP" (Fong, p. 27, in ESCAP, 1989). These are the most interesting and plausible results for the effects of family planning found in the models reviewed in this paper.

But the results for the remaining two independent variables are not so evidently plausible. Does the negative sign of the coefficient for Doctors/Population (statistically significant in 13 of 14 cases) reflect excluded correlation variables or an effect correlated with family planning?

The negative sign of income per capita (Y/Pop.) is also contrary to economic theory and may have the same ambiguous interpretation. However, the fact that the results are insignificant for over half the age-location groups—and for all but one of the eight groups across ages 15-34—suggests another interpretation: that income per capita is collinear with age at marriage, where its negative effect has already been embodied in the prior function estimating determinants of age at marriage. In any case, the effects of income per capita on fertility must be small because spectacular increases in per capita output (doubling) over the 2000-2025 time period in the model are associated with only 1 to 2 per cent reductions in fertility in both urban and rural areas. Perhaps such results are consistent with the ideology of the current pro-natalist "new economic policy" in Malaysia. The contents of the marriage function may also indicate why no education variable is included in the fertility function itself, as it would have been collinear with age at marriage. While education surely has effects on fertility via age at marriage, it also has other important effects on marital fertility, such as the improvement of knowledge of and use of family planning, and the increase in women's employment.

A final question concerning the fertility function in ESCAP-Malaysia is its data base. The data used are apparently time-series data constructed for 1960-1980, presumably (no description of the process is provided) by interpolating/extrapolating point estimates of census and other data (see discussion above regarding Bachue-Colombia).

A second ESCAP model in the later 1989 series is that of Mathana and Yongyuth for Thailand. In contrast to the other ESCAP models, and preferable to them, the Mathana and Yongyuth model uses 1980 data for 72 provinces to estimate a cross-province fertility function. The result is as follows:

$$\log (\text{TFR} - 2.0) = 2.08 - .19\ (\%\text{Pop. secondary} + \text{educ.}) + .1005\ \text{Y/Pop.} - .0016\ (\text{Y/Pop.})_2.$$

The three coefficients are all significant. The income variables together result in fertility rising with income up to some level of income and then

falling thereafter. Presumably income is a proxy for modernization. While it is possible to conceive of some aspects of modernization that would lead to such a positive relation, apart from the income effect (such as better nutrition and fecundity, higher fertility from lower breast-feeding) and many other aspects associated with declines, the function used is rather contrived. It would be better to include those other aspects explicitly. Some could well be policy variables. In any case, the income effect is noted by the authors to be extremely small, making increases in education (female education is better) the main factor leading to an expected continuation of rapid fertility decline in Thailand; but only relatively high levels of education are expected to reduce fertility further. A third variable, the female labour-force participation rate, was tried but found statistically insignificant, perhaps because of its collinearity with education, and dropped. But it seems to me that theoretically appropriate variables, if their coefficients have the correct sign and plausible size, should be retained in simulation models even if statistically insignificant, to better model the long-run relationships between socio-economic development and change in demographic variables. All in all, the statistical aspects of the function are stronger than the substantive ones.

The third and last recent ESCAP model is that of Paqueo for the Philippines. He describes his entire demographic sub-model as straightforward, but it is anything but that. To begin with, the source of data used is unclear. The author only notes that the demographic model is calibrated using the 1975 census of population and other sources. Ogawa and others (ESCAP, 1989) does note that it is based on the period 1957-1977, suggesting that considerable artificial interpolation/extrapolation was done to create the "time-series" data base.

The estimated equation is:

$$\log \text{GMFR} = 8.03 - .0011\ (\text{personal Y/Pop.}) - .0045\ \text{IMR} - .006\ (\text{relative price of food})$$

GMFR (general marital fertility rate) is not as good a measure as the TFR since it does not control for female age distribution. The coefficients estimated for income and the IMR (infant morality rate) are statistically significant. IMR is lagged to incorporate the lagged effect of recognition of changes in infant mortality on fertility behavior, which is appropriate (though a one-year lag seems far too short: 10 years may be more consistent with human behaviour but is not feasible with such a short time-series). Since the income effect on fertility is seen by most economists as positive, the author must be viewing income as a proxy for aspects of modernization not captured by the other two explanatory variables. A more serious problem is the statistically significant *negative* sign for IMR, which is totally inconsistent with the literature (see discussion above and footnotes 10-12). The final explanatory variable—the relative price of food—is intriguing and has the theoretically correct negative sign, albeit statistically weak. The relationship which it is presumably intended to capture is that the higher the relative price of food, the higher the direct costs of children and, therefore, the lower the desired and actual family size. It reflects the cost, if not the net value, of children.

Finally, the ratio of rural-to-urban fertility is fixed and exogenous over time. This and the absence of education, family planning and female employment variables precludes any possibility for examining governmental policy effects on demographic variables except relative food prices and sectoral investment allocation, through the economic model.

In conclusion, regarding fertility, the functions used in the macro-economic–demographic models are generally based upon seriously misspecified behavioural equations with obvious key variables omitted, usually including family planning; are estimated from weak or even unspecified data-sets using inadequate or incompletely described statistical procedures; and in several instances involve explanatory variables projected to change at such unrealistic rates as to lead to unrealistically large changes (reductions) in fertility even without explicit education, health, population redistribution or family-planning programmes.

Mortality

There is less to say about the mortality functions. Plausible changes in mortality trends and their effects over the usual simulation period (e.g., 30 years) are generally much smaller than those in fertility or migration in those countries investigated in the models to date. In fact, it is not clear that treating mortality as exogenous is such a defect in economic-demographic models such as those under review. Early models, including Coale-Hoover and TEMPO, treated it as exogenous. The feedback effects on fertility, the age distribution, and therefore the economy are all generally empirically small. A relative lack of research and the resulting difficulty of specifying a plausible function relating—for example—governmental health expenditures to health conditions or mortality rates in a population is an additional reason for treating it as exogenous, at least in the initial stages of model development. The absence of a reliable basis for estimating mortality functions at the country level is also manifest in the use of an international cross-section function in half of the four original country-level Bachue models and in rather simplistic formulations in some of the ESCAP models.

We begin with the mortality function in Bachue-Philippines again. Given the lack of research (as the authors note on p. 227), the function Rodgers and others (1978) estimated from an international cross-section (table 2) may be defended as conceivable *a priori:*

$$e_0 = 87.2 - 3389/y + 76880/y^2 - 36.47G,$$

where y is GDP per capita in United States dollars and G = Gini-coefficient measuring income distribution. The inclusion of a variable to measure income distribution is novel and plausible; it assumes that a more equal income distribution lowers mortality. However, it is not explained (Rodgers and others, 1978, pp. 38-39, 227); no matter, its effect is trivial. The non-linear effect of y on e_0 is appropriate, though it might be better captured by a logistic function (Preston, 1975a, 1975b; Chao, 1979).

But let us look more carefully at the mortality function in the context of the overall model structure. Given that income growth is exogenous and assumed to be quite high, mortality is essentially exogenous and also

TABLE 2. CHARACTERISTICS OF MORTALITY FUNCTIONS IN CERTAIN DEMOGRAPHIC MODELS[a]

	Bachue-Philippines	*Bachue-Kenya*	*Bachue-Colombia*	*Bachue-International*	*ESCAP-Indonesia*	*ESCAP-Malaysia*	*ESCAP-Thailand*	*ESCAP-Philippines*
Measurement of fertility.....	e_0	$1-{}_3q_0$	Female e_0	Female e_0	${}_5q_0$	e_0	e_0	IMR
Explanatory variables								
Education		Adult female literacy		Adult illiteracy	Educational level	Educational level	Educational level	
Income.....	Y/Population	Y/EAC	Y/Population	Y/Population	Mean household consumption	Y/Population	Y/Population	$\frac{\text{Private consumption}}{\text{Population}}$
Nutrition/ health.....			Cumulated governmental expenditure on health	$\frac{\text{Doctors}}{\text{Population}}$		Water access	Governmental expenditure on health and population	
Population distribution					Percentage urban	Separate urban/ rural functions	Percentage urban	
Other.....	Income distribution[b]	Time (year) Income distribution		Percentage Y of lower 40%	Proportion of births to girls 15-19		Fertility in previous year	Relative price of food; mean hours worked

NOTES:

${}_5q_0$ = Proportion of children dying before fifth birthday
ASMR = Age-specific mortality rate
EAC = Equivalent adult consumer
Educational level = percentage of population age 6+ with post-primary schooling
Water access = percentage of population with access to piped water

[a] Estimation is based on the same data as in table 1.
[b] Measured by the Gini coefficient.

assumed to decline rapidly. Apart from whether the resulting decline is reasonable given the recent deceleration in mortality declines in developing countries, the implicit assumption of an exogenous mortality function may be appropriate for a basic planning model (see below) but not for a sophisticated Bachue model. Of the many possible missing variables that come to mind as plausible and operational, two—education level and health facilities—were found useful by Chao (1979)[17] in cross-country regressions using a recursive model.[18] They also have the virtue of being related to policy parameters.

As with fertility, the mortality function in Bachue-Kenya was also estimated across both districts and households. For the former, e_0 was a function of adult literacy, total fertility rate, percentage urban, agricultural land per person (computations per household or adult would be better), presence of malaria in district, and persons per hospital bed. Agricultural land is adjusted for climate (rainfall) and considered by the authors as a proxy for per capita income. But in many countries where sub-national income or wage data are not available, electricity use is available across areas.[19] In any case, the mortality function is a reasonable, cross-sectoral representation. For the micro function, the authors decided, after some experimentation, to use the probability of surviving to age 3 ($1 - {}_3q_0$) as the dependent variable, with the independent variables being date of birth (for period effects), sex, parity, presence of malaria, household income per equivalent adult consumer (better than per capita since it adjusts for differences in consumption requirements of different age groups), urban/rural residence, education and health of mother, source (reflecting quality) of drinking water, type of toilet and medical care after birth. In practice, however, the macro function actually used in the simulation is neither the pure macro nor pure micro function, since specification error (missing variables) and multicollinearity pervade the former, and many micro-level variables are not appropriate at the macro level. In any case, the authors themselves note that the micro function is too complex (Anker and Knowles, 1983, p. 476).

Each of the three variables ultimately used (see table 2) was statistically significant in earlier regressions, which also included presence of malaria in the district. Income effects are appropriately specified as a combination of a positive linear and negative quadratic term so that its effect on reducing fertility is attenuated over time. Increases in female literacy increase child survival, and so does time itself (year of birth), presumed to reflect missing variables which rise (steadily?) over time, "such as improvements in medical technology, disease control, and public health programs" (*ibid.*, p. 479). Of course, such an interpretation is moot. More important, the coefficients of education and time appear rather small (means of independent variables are nowhere provided, obviating computations of Beta coefficients or elasticities for non-obvious variables, such as income). The authors state that the statistically estimated micro coefficients were simply (and arbitrarily) multiplied by two in order to make them less trivial, but they still seem small. If over 20 years, for example, the proportion of literate women rose from .20 to .30, survival to age 3 would only increase from around .85 to .856. Similarly, time itself would only raise the probability from .85 to .87. Most developing countries have achieved far more rapid reductions in mortality in recent decades.

The other two Bachue mortality functions will again be treated more summarily, largely because of the absence of detailed documentation. The dependent variable in Bachue-Yugoslavia (Macura and Popovic, 1984) is ${}_5q_0$, specified as a function of e_5 (again, exogenous), female education, percentage of illegitimate births, regional dummies (for the eight regions in Yugoslavia), and mean land size and female participation in agriculture. The sign the authors expect for the last variable is unclear, as is its presence. All explanatory variables are strictly exogenous except female education, as was the case with Bachue-Kenya. Finally, the mortality function in Bachue-Brazil is again the most problematic, with the dependent variable male e_0 and the explanatory variables income distribution, percentage of adults literate and percentage of labour force in primary and secondary sectors. An (unspecified) international cross-section was said to have been used (Braganca and others, 1980), but it did not include any income variable.

The mortality function in Bachue-International, estimated from a cross-section of 25 countries, is:

$$e_0 = 69.9 - 1500 \left(\frac{1}{\text{income per capita}} \right) + .27\ (\%\ \text{Y of lower } 40\%) - .20 \text{ illiteracy} + .00008 \frac{\text{Doctors}}{\text{Pop.}}$$

Only the education variable was significant, but this was only bad luck. In a simulation, the significance level is not known by the computer. What is important is which variables are included and their relative size. Without mean values of the independent variables or units in which they are expressed (not provided in the book: see its appendix A), a reader cannot determine relative effects. The signs of all the variables are consistent with expectations, although medical personnel is highly collinear with income per capita. Still, it is desirable to retain it since it is a policy variable. The author explicitly states there is no urban/rural term (or differential) because "it is not clear whether health conditions are better or worse in urban areas" (Moreland, 1984, p. 74; cf. also p. 19). This is so contrary to available evidence as to not be worth comment. Finally, the asymptotic effects of income per capita are nicely captured by the inverted term.

Unlike the other Bachue models above, Banguero (1981, pp. 35 ff.) gives considerable attention to specifying a mortality function and includes a public-policy variable. However, his dependent variable is female life expectancy, which is not as easy to relate to governmental policy variables as the infant mortality rate. Still there are several appealing features of the Banguero approach, including the specification of mortality by a single parameter using the Brass-logit life-table approach. The explanatory variables are indicated in table 2. Both have the expected positive effects, though governmental health expenditures are not statistically significant. Note that the latter is also not specified in cumulative fashion (as in Paqueo) and thereby has more short-run, direct policy effects.

Moving to the ESCAP mortality functions, Sigit uses areal data constructed from the 1976 Java/Bali World Fertility Survey for Indonesia, with the dependent variable specified as the proportion of children not surviving to the fifth birthday, which combines infant and child mortality. I see neither problems nor advantages in such a specification instead of the more customary infant mortality rate. In addition to time (presumably to capture unexplained secular effects), the other variables are indicated in table 1. All coefficients are expected to be negative, except for the last, which is novel and attempts to capture the effect of higher mortality on teen-age mothers. Unfortunately, its estimated coefficient is so small as to make the effect trivial, which is to be expected given the small proportion of births to teen-agers. Consumption expenditures per household is of similar value to income per capita. The education variable is appropriate but might be better specified as female education, judging from the growing literature on determinants of infant/child mortality in developing countries. Including percentage urban is defensible, though separate functions for rural and urban areas are better, to allow the slopes of other explanatory variables to vary between areas. Finally, the time variable may be the dominant variable in the regression, but this is impossible to judge since the author presents no standard errors for the regression coefficients.

For the Republic of Korea, Koo (1983) specifies mortality (female life expectancy) as a function of income per capita and time. Since income per capita rises exogenously over time in the projection, the function is of little interest: mortality changes exogenously, there being no behavioural or policy variables.

In the Malaysian model of Fong (1989), life expectation at birth was separately estimated for each sex in urban and rural areas as a function of three variables (table 2), each reflecting appropriate influences on secular changes in mortality. All (four) coefficients for income per capita have the correct positive sign and are statistically significant at the usual (5 per cent) level, but only three are significant for water access and none for education. Moreover, in rural areas, both signs for water access (for each sex) are incorrect (negative) precisely where one would expect the variable to have larger positive effects; and both signs for education are incorrect (negative) in urban areas. If the signs are not theoretically appropriate, they evidently should not be used in a long-run simulation framework—that is, they imply that increases in (urban) education and (rural) access to water raise mortality. Thus, while the goal of the ESCAP-Malaysia model is laudable—to incorporate theoretically appropriate effects beyond those of income per capita, focused on in other models—it did not work out. It would have been better to revert to a simple function relating life expectancy to income per capita with perhaps a log transformation or quadratic term to reduce the effect of increases in Y/Pop. on mortality over time.

In the Thailand model, Mathana and Yongyuth (1989) specify separate functions for male and female life expectancy (table 2). The effect of percentage urban is completely insignificant, which is not surprising when the other two are included, and is again an argument for specification of separate urban and rural mortality functions. Statistically significant, positive effects are observed for the other two explanatory variables, as expected. An income per capita squared term is also included with a negative, significant, coefficient, indicating smaller effects of

increases in income as life expectancy rises, consistent with Winegarden (1980). The authors also use a specification of the dependent variable—log $(77 - e_0)$ for females—which permits life expectation at birth to rise only to 77 asymptotically during the projection period (72 for males). This is reasonable for most developing countries and helps ensure that even the most positive rates of economic growth do not lead to absurdly low levels of mortality during the simulation period.[20] In conclusion, despite good *t* coefficients, the function has limitations similar to the other ESCAP functions described earlier (i.e., limited variables and none reflecting policy).

In the Philippines model (Paqueo, 1989), the mortality function is more plausible than the fertility or internal migration (see below) functions. The dependent variable is measured by the infant mortality rate. Mortality at other ages is linked to infant mortality through the use of the Brass-logit procedure, a convenient specification which also ensures that the age-specific mortality rates change in a consistent fashion over the projection period. The infant mortality rate is specified as a function of variables indicated in table 2, all of which are statistically significant. Unfortunately, there are problems regarding each variable when one considers it with more care. First, it is not clear why hours of work is included (employment effect? effect of higher hours of work of female workers away from home on infant/child mortality?). A few researchers have observed the latter, though I believe it is so minor as to be best ignored, certainly in a long-run time-series simulation model. Moreover, the negative relationship estimated is contrary to this hypothesis anyway, and no theoretical basis for the relationship is provided. On the other hand, the relative price of food is an exciting and novel variable and has a strong, positive effect, consistent with the theoretical view that the lower the price of food, the more likely parents will be able to feed their children adequately. The private-consumption-expenditures variable also has the expected negative sign, as does cumulated governmental health expenditures. But one wonders why the latter is cumulated, since what year, and why no depreciation or lag is allowed for its impact. A lagged effect could be nicely specified with a distributed lag formulation, to incorporate the declining effects of expenditures further back in time.

It is also curious that there is no variable representing fertility (see also Ogawa and others, 1989) or the percentage of women breast-feeding, despite the known, ongoing decline in breast-feeding in the Philippines, which the author is aware of from other research. Finally, he assumes a fixed ratio of rural-to-urban death rates throughout the projection, which he notes is "problematic".

Migration

Of the three demographic variables, migration is the one handled best in the Bachue models and worst in the ESCAP models. There are probably two interrelated reasons for the former: the models were developed largely by economists, and the key role of migration (particularly rural/urban migration) in economic development is well established in the dualistic theory of economic development (Lewis, 1954; Fei and Ranis, 1964). Yet simpler, pre-Bachue models had difficulty developing endogenous functions that would not lead to *all* of the population living in urban areas in the near future (e.g., TEMPO-II; see McFarland and others, 1973).

Beginning with Bachue-Philippines, each model in the Bachue family used an intriguing macro/micro migration function. First, a macro migration function is developed to model migration between areas as a function (typically) of income differentials and income distribution (measured as the Gini coefficient or the coefficient of variation of income) in origin (e.g., rural) and destination (e.g., urban) areas. The macro function estimated in Bachue-Philippines was:

$$M_{ij} = .37 \frac{Y_j/Pop_{\cdot j}}{Y_i/Pop_{\cdot i}} - .74\,YD_j + .03\,YD_i,$$

where M_{ij} is the volume of (gross) migration from origin i to destination j, and YD refers to income distribution as measured by the coefficient of variation (dispersion) of income in regions i and j. The relative income variable is positive and statistically significant, as expected, as is the negative sign of YD_j. Presumably, the worse the income distribution *inj*, the worse the job opportunities (Rodgers and others, 1978, p. 223). Origin income distribution did not have much effect, but its positive sign was correct *a priori*. Variables tested but found not significant in the macro migration function included distance between areas, percentage employment in the "modern" sector, percentage of children enrolled in secondary schools, whether there is electricity and whether there is access to potable water, all measured at both origin and destination areas. It is surprising that none of these other variables (even distance!) was significant, but laudatory that they were all tried.

Once the appropriate gross flows in each direction are determined from macro migration functions in Bachue, they are translated into specific flows by taking into account propensities to migrate by age, sex and education. Thus, not only are aggregate flows modelled reasonably with the macro/micro function, but so are the *characteristics* of migrants taken into account.[21] Nevertheless, I have two minor quibbles with the function in Bachue-Philippines. First, income distribution (within areas) is included with little explanation and no supporting evidence from other studies; and secondly, the restriction on urbanization to a maximum level of 50 per cent by the year 2000 implies a rather dramatic slowing of rural/urban migration in the latter years of the projection period (1970-2000). Such a slowing may be exaggerated, particularly since the absorptive capacity of urban areas will continue to increase.[22]

The micro/macro migration function in Bachue-Kenya is similar to that of Bachue-Philippines except it uses a *net* rural/urban specification of migration. Such a formulation is slightly inferior because it assumes that the characteristics of migrants moving in each direction are identical, which is unnecessary. The function estimates net rural/urban migration as dependent on the size of the rural population and its overall propensity to migrate, with the latter converted to the appropriate distribution by age, sex and education based on parameters estimated from household survey data in the micro function. The overall propensity is modeled by a macro function, based on cross-district ($n = 39$) data, with the variables tried indicated in table 3 (Anker and Knowles, 1983, chap. 18, pp. 100 ff).

Earlier regressions estimated migration between districts as a function of distance variables to various key cities, percentage literate and percen-

TABLE 3. CHARACTERISTICS OF INTERNAL MIGRATION FUNCTIONS IN SOME MACRO-ECONOMIC-DEMOGRAPHIC MODELS

	Bachue-Philippines	*Bachue-Kenya*	*Bachue-International*	*Bachue-Colombia*	*ESCAP-Thailand*
Measurement of variable (macro)	Gross migration, i to j	Net migration district i	Net R/U migration	Net R/U migration	Percentage U
Areas used	200 locations	39 rural districts	Cross-section of 19 countries	Constructed time-series 1960-1975	Cross-section, 72 provinces
Explanatory variables					
Education ...		Adult literacy	Adult illiteracy, per cent	Percentage R illiterate	
Income.....	$\frac{Y_j/Pop._j}{Y_i/Pop._i}$	$\frac{Y^u/LF^u}{Y^r/LF^r}$	Percentage difference in U/R incomes	Percentage difference in Y/Pop. U/R	Y/Pop.
Employment					Percentage LF in agriculture
Other	Income distribution in i and j	$\frac{Y^r/EAC^r}{Y^u/EAC^u}$			

NOTES:

R = rural
U = urban

Y = income
LF = labour force

tage urban in origin district, land per worker, and average or expected earnings levels (incorporating probability of employment according to Todaro (1969)) in both origin and destination provinces, based on census data. All coefficients were significant except those for land and origin earnings. But those results needed to be converted to a rural/urban specification. The coefficients of origin-and-destination expected earnings were simply taken as estimates of effects of rural/urban income differences (though the former was not significant, its size was half the latter, which is at least plausible in a long-run simulation—certainly better than dropping it). And it was assumed (no basis given) that two thirds of the education effect would be reflected in the micro selectivity function, so the estimated coefficient was reduced to one third its estimated value, once again reflecting as much "art" as science. But the additional variable incorporated (rates of incomes) was not in the estimated function and seems extraneous (redundant, multicollinear) in the final macro function used in the model, given that the other two variables are already included. This

probably leads to exaggerated effects of income differences on future migration flows, and perhaps faster reductions in urban/rural income differentials and, ultimately, in the migration they cause.

Bachue-Yugoslavia is said to include temporary as well as long-term out-migration, though in the absence of documentation, I am dubious about how this can be done, or about its importance in the context of a long-run model. As a regional model, it models gross migration flows between the eight regions of Yugoslavia as functions of wage levels, percentage growth in employment, unemployment rates and regional dummies. There would appear to be simultaneous-equations bias in the inclusion of the percentage increase in employment as a right-hand-side variable.

The authors of Bachue-Brazil modelled the propensity of household heads to migrate as a function of the urban/rural income differential, education of head, number of children and age of head, with the relationships estimated on the basis of household survey data. The number of migrants implied by the micro function as migrating from rural to urban areas each year of the projection was then adjusted up or down to be consistent with total migration flows independently estimated from the macro function. The authors note that only 17 per cent of long-term migrants in Brazil were rural/urban migrants (Braganca and others, 1980, pp. 37 ff.)

In Bachue-International, the macro function estimated is for net rural/urban migration, as follows:

$$M = 6.9 - 1.04 \text{ Illit.} + .65(\%\text{diff. in U/R income}).$$

Both coefficients are statistically significant and have the correct sign. Other variables tried and found wanting reflected an additional theoretically appropriate variable, availability of agricultural land—that is, average farm size and the Gini coefficient measuring inequality in the distribution of landholdings. It is unfortunate that the latter variable was not significant. Actually, the number of countries used was, for inexplicable reasons, reduced from 38 in some runs to 19 in the preferred run; also, as noted elsewhere, an educational attainment variable would have been better than the crude illiteracy variable, and would allow better linking the education variable to the education subsystem in a country.

The last Bachue migration function is that of Banguero for Colombia (table 3), where the dependent variable is the rural/urban migration rate with the initial period rural population appropriately used as the denominator. Both independent variables have the expected signs (negative and positive, respectively), but the coefficient of income is small and not statistically significant. This is unfortunate since it is the most important factor *a priori*. The coefficient of the illiteracy rate is highly significant, though small, so that, over time, increases in education lead to only a small effect on rural/urban migration. A fixed pattern of propensities to migrate by age is assumed, as in other models. There is no discussion of sex differences, suggesting that the same age pattern is assumed for both sexes, which is not strictly correct for most countries. Although the main discussion of migration is in Banguero (1981), pages 49-51, a subsequent chapter (IV) has an interesting discussion of the expected deceleration in rural/urban migration as urban areas approach saturation levels (*ibid.*, p. 151). Rural/urban income differences decrease over time in the basic reference run.

Wéry and Rodgers (1980) note that none of the Bachue (or ESCAP) models keeps track of migrants in urban areas separately from the native urban population. This could be useful for modelling the process of fertility adaptation of in-migrants and therefore long-run fertility decline, for example.[23]

The discussion of the Bachue models above has indicated the important, integral role of internal migration in the process of economic development and demographic change in the Bachue models. The role of internal migration will be seen to be considerably weaker in the ESCAP models. We begin with Sigit for Indonesia and Koo for the Republic of Korea. Sigit (1983, p. 26) declares that the income disparity between agriculture and non-agriculture will persist over time and cannot be influenced by policy. This seems anomalous in a country where explicit governmental policies of massive transmigration have been used for years to redistribute the population and where other direct policies have been used to try to prohibit migrants from entering Jakarta. Of course, there does exist such a (potential equilibrating) mechanism—internal migration itself—which is an integral part of the process of economic development. In all fairness, Sigit states that he did try to estimate percentage of population in agriculture, using some form of Harris/Todaro function to estimate determinants of rural/urban migration from time-series data, but the migration function was not satisfactory. Thus, in the end the urban/rural population distribution is assumed to be a constant function of relative employment, which is determined from separate production functions. While it is not clear from the author's discussion what data were used or how the Harris/Todaro function was formulated, internal migration should not be just dropped from the model.

The Koo model for the Republic of Korea is similar, which explains its absence as well from table 3 (other ESCAP models are similarly omitted). The proportion of rural farm population is simply expressed as a function of the average productivity of labor in the economy, which is computed from data in the economic model (Koo, 1983, p. 61). Thus, there is no effect of income differences between areas. Rural/urban migration is then simply computed as a residual from the projection of the total population and the farm population each year. The resulting implied number of total (net) migrants is then distributed by age and sex using a constant set of age/sex-specific migration propensities, as in the Bachue models. In the Republic of Korea these are greater for females at ages 10-24 and for males at 25-49. For both sexes, higher propensities are used for the younger population, 10-24, which is consistent with experience in other countries. The propensities presumed do not present any particular problems, and the higher propensities for young females than young males have also recently been observed in Latin America (e.g., in Ecuador by Bilsborrow and Fuller, 1988).

Continuing with the more recent ESCAP models, for Malaysia (Fong, 1989) percentage urban is simply estimated as a function of income per capita, with total net migrants again computed as a residual—namely, the difference between this urban population and that resulting from the "supply side" by applying estimated urban and rural fertility rates to the previous period urban population. But this is not really a migration function at all.

Mathan and Yongyuth for Thailand and Paqueo for the Philippines go a step further, incorporating a direct effect of the sectoral distribution of the labor force. In the case of Thailand, the function is:

$$\log \frac{.5 - \%U}{\%U} = -.006 + .013 \text{ Y/Pop.} - 3.52 \text{ (\% LF in agriculture)} + 5.97 \text{ (\% LF in agriculture)}^2$$

The only significant coefficient is the last one, which is also the only one with the appropriate sign. Since the coefficient for income per capita is tiny, percentage of the labour force in agriculture is the main substantive determinant. This is virtually identical with the functions of Koo and Fong above, with no relationship postulated between migration and rural/urban income differences. In both Thailand and the Philippines, the percentage of the labour force in agriculture is not evidently related to any endogenous variable in the model, so the rural/urban population distribution and implied net internal migration (again computed as a residual) appear to be strictly exogenous.

General Weaknesses in Model Economics and Model Structures

Certain of the technical difficulties confronted by all macro-economic–demographic models go beyond inadequate data or functional relationships. One is the treatment of technological change, with the usual assumption being fixed technology (e.g., fixed input/output coefficients, fixed elasticities in the production function, or fixed Engel curves), which hardly seems appropriate in a 30-year projection period. Fortunately, evidence now exists on how to model changing technology over time, at least "smooth" technological changes.[24] A related point is that few models make any attempt to incorporate the determinants of fixed investment, though there is a substantial body of literature on the subject, and such functions are key components of annualized econometric country models. Demand-oriented models such as Bachue typically have no direct effect of investment on production or labour except in agriculture. Another problem area has been the modeling of labour markets and wages. In models which incorporate both demand and supply, determining equilibrium conditions and adjustment mechanisms has been a major difficulty, beginning with TEMPO-II.[25] In general, incorporating the adaptive functions of changes in prices and technology is rarely attempted (Nordhaus, 1973), nor are international factors taken into account, exports and imports both usually being exogenous (though they are included in Bachue-Kenya as a supply constraint). Whether it is necessary or realistic to take such factors into account depends on the *type* of economic-demographic model.

With respect to other economic aspects of the models, most models have given the agricultural sector little attention, despite its dominant size in low-income economies. For example, it is usually treated as a single, amorphous sector with no capital or educated labour embodied in the production function. Also, the process of modeling a surplus to be transferred for investment outside the sector is not modelled, despite the dualistic structure of the models. There are also other unresolved issues relating to

the determination of the level of disaggregation and whether the model is intended to cope with long-run structural changes or institutional changes, and the effects of the latter on equilibrium conditions.

The economic-demographic models which have evolved are essentially of two distinct types: supply models of the Coale-Hoover and TEMPO types, and the demand models of the Bachue family. Supply models ignore the role of changing patterns of demand over time and space as incomes rise, while demand models assume output growth to be exogenous. Demand models have essentially no feedback from population to economic growth since economic growth is assumed to be exogenous,[26] while supply models have no feedback from the economy to the population. Clearly what is needed ultimately are models which incorporate major features of the supply side (including production functions for at least two sectors) and the demand side (including major consumption categories whose demand composition changes over time). But perhaps the biggest weakness in most existing models is the treatment of the governmental sector, to which we now turn.

The governmental sector and policy inferences

The developers of the Bachue models intended that they be usable to simulate the effects of a number of governmental policies on the future course of economic and demographic variables. For example, the list of policy simulations carried out with Bachue-Kenya included the imposition of an exogenous family-planning programme (assumed to reduce total fertility by 30 per cent over 30 years), increases in school enrolment and public health expenditures, and policies assumed to reduce rural-to-urban migration (including land reform and redistribution, and shifting physical investment between rural and urban areas). These are certainly major policy options and the focus of much of the economic development literature. The set of policies investigated with Bachue-Philippines is similar and even more extensive. The effects of policies in complex models are not obvious. For example, note the contrast in the effects of a reduction in rural-to-urban migration in these two Bachue models: Although the effects on the overall rate of economic growth are different—in Kenya economic growth is simulated to increase as a consequence of increased rural production and increased foreign exchange earnings from agricultural exports, while in the Philippines overall economic growth declined because the decline in urban production exceeded the increase in rural production—nevertheless, in both, income distribution worsened so that both authors recommended against governmental attempts to control rural-to-urban migration. Such results are not obvious *a priori,* and indicate a significant contribution of complex models to our understanding of the implications of governmental policies.

In addition to their many shortcomings indicated above, there is another reason why we learn virtually nothing useful about policies relating to fertility or mortality from the Bachue or ESCAP models: the governmental sector is virtually ignored. This rules out exploring most relevant policy issues in a realistic way (regarding Bachue-Philippines, see pp. 30, 31, 119, 120, 124), such as trade-offs between governmental

expenditures on education, health, and family planning versus, for example, direct investment in agriculture versus industry, or in rural versus urban areas. In Bachue-Philippines, education, public works and direct investment are included as exogenous parameters without even implicit trade-offs because of the lack of expenditure functions. This does not seem necessary. For example, higher population growth leads to either lower future school enrolment ratios (if education expenditures are fixed) or increasing education expenditures (if school enrolment targets are fixed, as in national development plans). The latter, in turn, requires less expenditures on some other public sector; the former has indirect long-run effects on fertility, labour productivity, health and mortality and probably internal migration. Even simpler linear functions to model education costs could achieve the implicit trade-offs and allow some investigation of policies. Moreover, the investigation of the effects of increases in rural education (Rodgers and others, 1978, p. 18) requires separate cost functions for schools in urban and rural areas (unit costs being much lower in rural areas), but one does not see those parameters in the models. In fact, since the education subsector is so important and relatively easily modelled, failure to model it better would appear to be a major, remediable shortcoming of Bachue and ESCAP models (one exception being Banguero). In fact, in rural areas, school attendance of children should be considered endogenous, related to both the availability of schools and the availability of rural land and household production needs, since children contribute to production beginning at early ages.

In these existing models, policies are assumed to be implemented without cost and, therefore, without trade-offs or implications for other governmental policies: Family-planning programme effects are simulated at no cost, rural-to-urban migration restrictions are miraculously effective without specifying underlying policies or costs, health programmes improve health and mortality without cost. There are similarly few interrelationships between governmental revenues and the level or growth of production or its sectoral distribution between imports and exports, for example. Governmental expenditures are implicitly assumed to be necessary to achieve various levels of provision of services in the future, such as education, with no regard for the source of governmental revenue. Thus, the entire governmental revenue side is usually exogenous, even when parts of the expenditure side are not.

But incorrect inferences about the effects of policies can also result from inadequate behavioural functions. For example, in Bachue-Philippines, there is one area where policy implications widely disseminated by the authors cannot be accepted. I refer to statements that policies to reduce fertility are "unlikely to have much pay-off in the Philippines within a reasonable time horizon" (Rodgers and others, 1978, p. 13). A major reason for this statement is that "in the reference run, the crude birth rate declines from 45 in 1965 to 29 in 2000, mostly as a consequence of socio-economic changes" (*ibid.*, p. 12). That is, the high level of fertility in the Philippines in the 1970s is assumed to decline dramatically even without any policy intervention. What is especially remarkable is that this is achieved without any significant effects of increases in female education or female labour-force participation rates either. In fact, the dramatic decline in fertility is essentially exogenous. The Bachue fertility function is

largely a function of mortality, with mortality basically a function of income. Since a rapid increase in income is assumed in the reference run (7 per cent per capita per year), then mortality declines dramatically and so, therefore, does fertility. Thus, the major determinant of future changes in mortality, fertility and population growth is the exogenously *assumed* dramatic increase in output.[27] Since neither mortality nor fertility is in essence endogenous, the model's claims to be an economic-demographic model are weakened. Thus, also, the effects on economic development of changes in policies expected to affect internal migration are much greater than those which affect fertility in Bachue-Philippines because of the underlying model structure. Structural and policy factors that may affect fertility are not embodied in the model. Thus, the model is teleological, in the sense of having the conclusion about the unimportance of fertility embodied *a priori* in the model structure, just as the Coale-Hoover-type neo-classical supply models had their basic result—higher fertility leads to lower growth in per capita output—inherent in the model structure (Arthur and McNicoll, 1975, p. 257; Keeley, 1976), and just as the Simon model (1977) has population growth solving its own problems because of the inclusion of population size in the technological progress function.

A somewhat exceptional model is that of Banguero for Colombia, which has total governmental consumption as a simple function of total GNP (p. 67), with governmental saving treated similarly, both growing exogenously as the economy grows (p. 69a). But Banguero does include some explicit demographic and economic effects of—but not the budgetary requirements for—increases in governmental programmes on education and health, among others. He also explores various policy simulations, changing, for example, the portion of governmental budget expenditures on education (from 14.3 to 15.8 per cent) and health (from 27.4 to 29.4 per cent), and observes the long-run effects. The effects on economic growth are positive because of the increase in labour productivity, given the role of education and health in Banguero's production function. A number of other policy options are also explored by Banguero, including increasing the labour intensity of production (by raising the coefficient of unskilled labour in the production function, though it is not clear how this is justified), tax reform (increasing taxes on capital relative to labour), and an "essential human needs strategy", which combines all of the above, to reallocate expenditures so as to benefit lower-income groups.

The public sector is also not treated fully in the recent ESCAP models, though there also are some interesting variables here and there. First, the Sigit (1983, p. 24) model for Indonesia uses a short time-series (1969-1978) to relate total governmental revenues to a single explanatory variable (GDP), estimating a coefficient of .31. Given the huge growth in income projected in the model (see discussion above) based on the atypical years of the reference period, it is not surprising that governmental savings rise from 4 to 11 per cent of total gross domestic product during the 30-year projection period (1979-2010). Such an increase should have, in itself, raised a red flag. In contrast, the Koo model for the Republic of Korea (Koo, 1983, pp. 55-56) takes total governmental consumption as proportional to private consumption, with governmental investment undistributed among sectors or locations. The Fong model for Malaysia also has no expenditure functions for the public sector; and for the Philippines,

Paqueo uses only cumulated health expenditures (which affect infant mortality) and other governmental expenditures (which affect urban employment in governmental services). On the revenue side, Paqueo has a payroll tax on workers which is applied equally in all sectors, agricultural as well as urban, which does not seem plausible. On the other hand, it seems less necessary to include revenue functions (in contrast to expenditure functions) in simple macro-economic–demographic models since governmental revenues in most developing countries come largely from import and export levies, excise taxes, and foreign aid (all exogenous).

Given the importance of the governmental sector and its inadequate representation in existing macro-economic–demographic models, much more research is needed on the specification of functions relating public-sector expenditures to the availability of specific facilities and, in turn, on the effects of more facilities on human behavior. For example, what are the effects of increases in education expenditures on the availability of schools in rural areas? And what are the effects of that increased availability on actual school attendance, rural production, fertility norms and behaviour and out-migration? Similar queries can be raised about governmental expenditures on health, family planning,[28] provision of potable water and so forth. In general, essentially two pieces of information are needed: a production function relating governmental expenditure inputs to programme outputs; and behavioural information about the effects of governmental facilities on household behaviour, to be estimated ideally from household survey data.[29] The latter requires better behavioural functions to be estimated from household decision-making models, perhaps including community variables (regarding fertility, see Bilsborrow and Guilkey, 1987).

Lessons learned and suggestions for future modelling

Developing a detailed simulation model is a very ambitious and complex undertaking. Analysis of non-demographic aspects of the models has been beyond the scope of this paper. Rather, my intention has been to indicate positive aspects of the various demographic functions used in the simulation models, as well as their shortcomings. In each case, the shortcomings are described not in relation to some fixed concept of an ideal function—because every country's situation and data base are different—but in the context of what might have been done better with the function attempted and available data. Lest the positive aspects be lost in the detailed discussion of problematic aspects, let me reiterate some salient conclusions. First, there is considerable diversity in the treatment of fertility in the Bachue and ESCAP models, with positive features in particular models of each genre, including a common tendency to include both education and female employment as explanatory variables. In addition, Bachue-Kenya has nicely modelled mortality effects on fertility and has separate urban and rural functions; ESCAP-Malaysia includes family planning with plausible effects; and ESCAP-Philippines has the relative cost of children (price of food). Regarding mortality, the ESCAP models built in upper asymptotes to restrain mortality from rising unrealistically under any scenario, and Bachue-Colombia and ESCAP-Philippines include plausible governmental health expenditure variables. On rural-to-urban migration,

the Bachue models developed a two-step macro/micro approach to determine, first, overall flows as functions of income differentials between areas and, then, to allocate them across age/sex/education groups according to observed propensities to migrate. Unfortunately only the latter aspect was incorporated into the ESCAP models.

Finally, hindsight is said to be better than foresight. Some 15 years have elapsed since the starting point of the simulations of some of the earlier Bachue models—half the period simulated (specifically Bachue-Philippines and Bachue-Kenya). It would be intriguing to compare and contrast the actual evolution of key demographic and related economic variables over the elapsed time period with the simulated paths, and investigate the similarities and differences.

Another issue that arises in comparing the Bachue and ESCAP models is the underlying data base. Is it better to use a cross-section or time-series data to estimate behavioural demographic functions? While there is no universal answer and it surely depends on what data are available in the country, my own prediction (to be made obsolete, I hope, during my own lifetime, with the availability of further repetitions of census/survey data collection) is towards analysing cross-sectional survey data, even a single cross-section, in contrast to a time-series constructed from only a few censuses and/or aggregated data prepared from household surveys. New demographic data are not available every year, as are national accounts, foreign trade and monetary data, but only when censuses or specialized surveys are undertaken—usually only every 10 years, in the case of the former. Annual figures are then estimated by interpolation, an artificial process used in most ESCAP models discussed above. In addition, census data are very thin, permitting very little exploration or estimation of key behavioural relationships, in contrast to the depth of information available in a household survey. Moreover, relationships observed from cross-sectional data are now commonly interpreted as reflecting long-run relationships which may be preferable to those estimable from more time-dependent time-series data. Nevertheless, structural changes in parameters estimated from cross-sections can and do occur over time, so using more than one past cross-section to test for stability over time would be desirable whenever comparable data are available.

Let me return now to the most complex and in many ways most complete of the (published) economic-demographic models, Bachue-Philippines. It has over 750 endogenous demographic variables and 1,000 endogenous economic variables, which can be reduced to "about 250 endogenous equations and identities" (Rodgers and others, 1978, p. 25), using matrix notation. When initially formulated, the model required a larger computer than any available in Geneva. Work on the model involved a number of person-years of some of the best economic talent in the world (ILO staff as well as outside consultants). In their implicit criticism of the model's complexity, Cole and Brown (1975, p. 37) refer to its "compounding errors" and "black-box" problems. Indeed, the Bachue model creators have confessed that sometimes "black boxes" exist for them as well.[30]

But are the Bachue-type models, including ESCAP models, useful? Yes. Have they been useful to planners in developing countries? Rarely, to date, it appears. Among the reasons are that they:

(*a*) are too complex for decision makers to have confidence in ("black boxes");

(*b*) require vast amounts of country-level data, some of which do not exist, leading to the estimation of coefficients from cross-country data, or are of very dubious quality (points emphasized by Robinson (1976) and Nordhaus (1973) in discussing the "limits to growth" global model of the Club of Rome);

(*c*) require too many person-years of high-level technical manpower, which is scarce in most developing countries;

(*d*) lack appropriate policy variables.

The lack of knowledge about how to model policy effects (see above) is also a fundamental weakness and requires more than economists to attempt to remedy.

So, what is to be done? First, recognize that Bachue models (and some ESCAP models, such as ESCAP-Philippines) are closer to research models than planning models and concentrate in the future on developing two "purer" species—planning models (or planning-aide models) and research models—in one or two countries. The need for such a distinction arises fundamentally out of the difficulty planners have in understanding complex models such as those in the Bachue family. If planners are not comfortable with their comprehension of the models, they are not likely to use them in the planning process.[31] A research model could be similar to, for example, Bachue-Philippines in structure and complexity but should also incorporate the supply side, a detailed specification of the government sector (including specific functions for education, health, family planning and investment allocation, across both economic sectors and space), and the best available behavioural functions, including demographic functions. With both demand and supply sides included, attention will need to be given to defining equilibrium conditions for "clearing" markets of products and labour, probably using computable general equilibrium (CGE) model formulations, as in Kelley and Williamson (1984) and the ESCAP model of Paqueo (1989).[32]

Existing macro-economic–demographic models have been developed largely by economists, which partly explains their weak demographics. The research-model developers should include one or more demographers and a highly qualified programmer as well. The model could be continually updated as new data become available, permitting better estimates of functional relationships. Modified results would then be produced, discussed and disseminated. Perhaps an international organization could co-house the model[33] jointly with a major research institute or the planning agency in a developing-country Government. It could provide assistance to the latter in not only modelling aspects but also identifying key behavioural parameters poorly specified because of inadequate data. Finally, improved communications between the research model and planning model staffs would be desirable.

What needs to be done in order to make these complex models more useful to planners? First, develop a simplified demand model and a separate supply model. (Some guidelines are suggested below.) The results could be routinely compared, to determine the respective advantages and shortcomings, and the need for linkages. Secondly, advance step by step,[34]

beginning with a very basic model, perhaps of the TEMPO-II type, then adding to it to incorporate greater endogeneity and realism as the capabilities of the country planner/modelers increase. The noted American urban planner/historian Lewis Mumford once wrote, "Make no small plans", but he also advised working "from the ground up". Thirdly, develop the planning models in the country, but with international technical assistance. An important reason that Bachue-Philippines and Bachue-Kenya did not have more effect on governmental decisions is that they were developed by non-nationals (see also United Nations, 1981). The two more recent Bachue models have been developed largely in-country, as have the ESCAP models—an important step. Fourthly, in planning models incorporate only the most dominant structural aspects of the economy (e.g., a petroleum sector in Indonesia or Mexico) to keep the economic structure from becoming so complex that it absorbs most of the attention of the model developers, to the neglect of demographic aspects.[35] This seems to have been the case with most of the current Bachue and ESCAP models, judging from the review above. Fifthly, incorporate a specification for the governmental sector to permit focusing on major policy issues. Sixthly, as with the research model, prepare a companion manual with documented computer guidelines (see below).

We have learned that the minimum desirable structural properties for a basic macro-economic–demographic planning model would include:

(*a*) at least two output sectors, in rural and urban areas;

(*b*) population disaggregated by age, sex, education and region;

(*c*) endogenous internal migration, as a macro function of the urban/rural income differential and perhaps rural land availability and mean family size;

(*d*) separate output supply and output demand models, beginning with the former;[36]

(*e*) in the demand model, the major consumption categories functionally related to household income, size, location and age composition;

(*f*) in the supply model, labour supply[37] to depend on age/sex/education/location participation rates (initially exogenous, perhaps later endogenous, drawing on lessons from the research model), and labour quality in the production function based on education and health levels (Correa, 1980; Banguero, 1981);

(*g*) marital fertility specified as a function of age, education, female employment and availability of family-planning facilities separately for urban/rural location;

(*h*) mortality (initially) exogenous, or modelled to respond slightly to health expenditures and education;

(*i*) the formulation of a governmental sector with, at least, expenditure-impact functions for education, health and family planning.

In terms of how to proceed operationally to achieve such planning models, one may scale down Bachue-type models or scale up TEMPO-II-type models. The former would appear easier if it already exists for the country; the latter, otherwise. Countries with an ESCAP model could use it as a starting point and revamp existing demographic and other functions.

We have also learned some important methodological and procedural lessons about creating economic-demographic models. First, the data and human resource demands of such models are so enormous that most third world countries should not attempt to develop comprehensive ones of either type. Indeed, the first stage of model development in any country should be to determine relevant data sources and quality[38] so as to identify gaps that need to be filled in before proceeding. Often the gaps will involve behavioural relationships that can be estimated from household survey data, in which case an appropriate multipurpose survey should be designed, undertaken and analysed before the model is developed. That was done for Bachue-Kenya.

Secondly, it is vital to test the sensitivity of model results to particular parameters and combinations of parameters, since synergistic effects may exist. Key parameters should include all those in the functions for the three main demographic variables discussed above as well as those in the major governmental expenditure functions (production functions for education, health and family planning). Where the sensitivity analysis suggests that model findings are particularly sensitive to a parameter whose value is suspect, the parameter should be re-examined.

Thirdly, it would be useful if some model developers could describe the difficult process of how they got the models to work, be stable and give plausible results. Perhaps this is the biggest "black box" of all. It would be extremely useful to future model builders to have a manual or technical paper that would explain the problems encountered and the solutions adopted. The usual publications rarely include such information. Perhaps such a manual could be produced as part of the first new "planning model" to be developed.

Fourthly, given the complexity of comprehensive models, it would be desirable in planning models to focus on the development of better *partial* modules for key sectors or topics in the country, such as agriculture, rural/urban migration, family-planning programme impacts, education costs and benefits, human resource development in general (Wheeler, 1980), and urban labour markets. Such modules could later be combined, with appropriate linkages to create models more usable for planning—not especially complex but with specialized treatments of sectors of particular importance to the country.

Fifthly, since our understanding of the interrelations between economic and demographic phenomena is rooted in the theory of household decision-making, it will sometimes be desirable to use simultaneous-equation estimations to obtain behavioural relationships from household-survey data. Such estimations should be an integral component of the research model and have been pioneered to a limited extent in the Bachue models. Nevertheless, for macro planning models, recursive relationships are surely adequate. For example, recent work of Wheeler (1984) found that the essential relations between income per capita, infant mortality rate, family planning programmes, education and fertility can be captured by a recursive model structure, which simplifies computations in a long-run simulation model.

Sixthly, better model development depends on further research not only on interrelated household economic and demographic decisions but

also on the effects of demographic factors on governmental decisions, on how Governments respond to economic and demographic pressures. Models need to become increasingly realistic and eventually recognize the "mediating role that human behavior and human institutions (including governments) play in the relation between population growth and economic process" (National Academy of Sciences, 1986, p. 4). Thus, parents make sacrifices to adapt to an extra child, economic systems respond to scarcity by altering prices, and political leaders change. Models which confront these topics would be dealing with issues on the frontiers of our knowledge of human behaviour.

In conclusion, given the gaps identified above and others not discussed here, we should not expect miracles of the economic-demographic models. They are not a panacea, and they will not miraculously indicate desirable development policies. But they can be useful planning aids in those third world countries which are relatively well endowed with the data and human capital needed for successful modelling. Moreover, they have probably also helped stimulate greater interest in planning in developing countries; have increased recognition of the need for a longer perspective, of the complexity of development and of the possibility of feedback effects that swamp apparent direct effects; and have helped identify data gaps and research needs.

Macro-economic–demographic models have a history of only about two decades, in contrast to econometric forecasting models which date back over five decades and which led to the first Nobel Prize in Economics. One of the recipients of that Prize declared a few years ago that even those models are still in a "primitive state" (Tinbergen, 1981).

NOTES

[1] Variations of TEMPO-II models have been developed in (at least) Colombia ("CERES"), Peru, Egypt and Venezuela, while Bachue models have been or are being implemented in the Philippines, Kenya, Yugoslavia and Brazil, etc.

[2] In a long-run model, suggestions of the sort made by Robinson (1976) to endogenize wages and prices in a general equilibrium framework seem an unnecessary refinement. See section III.

[3] References to country and world models include Rodgers, Hopkins and Wéry (1978), Coale and Hoover (1958), Enke and Zind (1969), Club of Rome and Meadows et al. (1972, 1974), Dayal (1981), Mesarovic and Pestel (1974), Hughes (1980), and the U.S. Commission on Environmental Quality (1980).

[4] A number of developing countries have also developed their own empirical economic-demographic models (e.g., Colombia, Egypt, Malaysia, Morocco, Peru, the Philippines, Thailand etc.) which—because of the general absence of documentation outside the country—cannot be included in the assessment.

[5] The country composition is not specified nor is the source of data for rural and urban estimates of GRR.

[6] In an earlier working paper, two of the authors (Rodgers and Wéry, 1977) compare the effects of education on fertility in the Philippines in the year 2000 using their function and other scholars' functions. They show that their results are not dramatically different from most of those selected. However, all but one of the other fertility functions were derived using simple ordinary least squares (OLS) estimation procedures. The only one based upon

more appropriate simultaneous equation techniques (Nerlove and Schultz, 1970) resulted in much *larger* declines in fertility by the year 2000—10 to 28 per cent vs. from 1 to 3 per cent as a result of increases in education.

[7] In my opinion, it was not hard to foresee years ago that the "education revolution" which began in developing countries in the 1950s and 1960s was likely to cause or assist fertility declines in many of those countries beginning in the 1970s as more educated women entered the child-bearing ages. I have not seen much research on this lagged relationship. One exception is Winegarden (1980), who found the effect of lagged education negative and statistically significant, in both ordinary least squares and 2-stage least squares estimations, for a cross-section of developing countries.

[8] As a positive relation is observed in comparing no education with primary education in the Philippines, the two lowest groups could be combined, yielding a slightly higher level of fertility in the lowest education group but substantially lower fertility in the more educated groups, which would, over time, be applicable to a continually increasing proportion of Filipino women.

[9] The authors allude to the need to estimate a more reasonable fertility function from more recent household-survey data in the Philippines and resimulate the entire model but have apparently never done this.

[10] Evidence on the linkages between child survival (or the IMR) and fertility is considerable (e.g., Schultz, 1976; Taylor and others, 1976; Schmitz, 1985; United Nations, 1988), growing out of the "child survival hypothesis". The recent impressive United Nations review clarifies the "insurance" and "replacement" motives, the purely physiological effects of birth intervals (all having negative effects), and "price effects" (positive).

[11] Using approximate Philippines values for the other variables in the equation (% FLFR = 30, % illiterate = 10, % LF in agriculture = 70, from pp. 162-163 of Bachue-Philippines), we have GRR = 5.07 − .0446 e_0, which has a mean value of 2.84 at e_0 = 50. For e_0 rising from, say, 50 to 60, the implied infant mortality rates (using the Coale-Demeny "West" model life table) are 118 and 71 (per 1,000). The decline in GRR is .446 (daughters), or a decline of .90 births. The elasticity of fertility with respect to (infant) mortality is thus (% change in fertility divided by % change in infant mortality) = (.446/2.84)/(47/118) = .394.

[12] Rutstein (1974) found the response about one-half birth per infant death in Taiwan Province. This means about one-fourth change in daughters per woman, so a fall in infant mortality by 47/118, or 40 per cent, decreases the GRR by only .25/3.00 (at a mean GRR of 3.0), or 8 per cent. The implied elasticity of GRR with respect to infant mortality is then 8/40, or 20 per cent. A number of other studies have observed similar or lower rates of replacement, including Anker and Knowles for Kenya (see below).

[13] See, among others, Lapham and Mauldin (1984), Winegarden (1980).

[14] A microcomputer version has subsequently been developed at the Research Triangle Institute, North Carolina, United States.

[15] The latter is difficult without Moreland's help since no computer (source) program or documentation is provided in the book. It is noteworthy that an IBM-PC version of Bachue-International has been developed in Jamaica.

[16] It is surely not necessary or plausible to consider the negative sign as "indicating that children are an inferior good" (Moreland, 1984, p. 74).

[17] Chao used medical personnel per 1,000 population. The number of health facilities, clinics or outposts may more closely capture the crucial importance of the distribution of facilities between urban and rural areas.

[18] Barlow and Davies (1974) and others found health factors important in the mortality decline in Sri Lanka. See also the DYNAPLAN health model developed by Bernstein and others (1985). Chao's recent cross-country estimation model yielded statistical results superior to those in Bachue-Philippines.

[19] This was, unfortunately, not the case in Kenya at the time, according to a private communication from Richard Anker.

[20] Ogawa and others (1989) note, however, the desirability of testing the sensitivity of coefficient estimates and simulation paths to the choice of upper limit in all three of the latter ESCAP mortality functions.

[21] Such a function was independently proposed earlier by Bilsborrow and Rives in a research proposal developed in January 1972 at Princeton University. The model was never implemented but was presented in 1976 in Cairo (see Bilsborrow and Rives, 1976, pp. 23-25).

[22] Evidence on the important role of the absorptive capacity of urban areas on the rate of rural/urban migration, based upon cross-country analysis, is found in Mundlak (1978) and Bilsborrow and Winegarden (1985).

[23] However, the proportions of migrants in each age/sex group in Kenya are computed and used in the fertility and income transfer (remittance) functions.

[24] However, it is difficult, if not impossible, to model what Chakravarty (1969) referred to many years ago as "structural breaks". It is inherent in models to deal with smooth, endogenous transitions.

[25] Adjusting labour demand and supply proved a major difficulty in Bachue-Kenya. After much experimentation, the rate of change in labour productivity in the modern sector was finally assumed to be a function of the proportion of educated adults actually employed in the modern sector. Even this is anomalous and, while validating the model over the 1969-1979 period, led to an unrealistic increase in real modern-sector wages, whereas in practice they declined (Knowles, 1980).

[26] For example, in the demand models, neither population size nor its quality influences output. Thus, increasing education has no effect on the level of production.

[27] Of course, if income per capita could really grow at 7 per cent per year for 30 years, the increase would bring enormous changes in any society and, *ipso facto*, in fertility.

[28] The TEMPO II model postulated a simple linear function relating family-planning expenditures to births averted. However, the relationship should be exponential, with expenditures required per new acceptor, after some early stage, rising considerably (Robinson and Horlacher, 1969, 1971; Slavin and Bilsborrow, 1977). The reason is that the effectiveness of family-planning programmes is likely to fall over time. At first, they attract those highly motivated women who desire to space (or limit) their births—usually older and higher-parity women. Later acceptors are likely to be less motivated and farther from clinic sites, so promotional activities are needed, raising unit costs. The unit cost function (whether for acceptors, users or estimated births averted) is therefore upward-sloping over time.

[29] One example is Rosenzweig and Wolpin (1982).

[30] "The more complex a model, . . . the larger the number of inexact relationships it contains, the more sensitive it is to various combinations of these relationships" (Anker and Farooq, 1978, p. 153). See also Arthur and McNicoll (1975) and Rodgers and others (1976).

[31] Of course, ultimately the perfect research model is better for planning than any planning model, since it is more complete and realistic.

[32] See also Sanderson (1980) and Kelley (1987, p. 23).

[33] I recommend that this be a United Nations agency with past experience in the area. The operation could be used as a training centre to bring high-level modelers from developing countries for several months to learn from the research model. In-country training programmes of several weeks by project staff would usually be desirable also.

[34] One of the most famous macro-economic modelers of the century stated that developing countries do not need detailed input/output tables but rather only a few sectoral tables (Klein, 1966, p. 321). He also noted the problem of (equilibrium) wage determination in models (p. 317), cited here as well.

[35] Since linking the two is a major difficulty, this would be investigated in the research model.

[36] Labour demand can be obtained implicitly from the production function (see Bilsborrow and Rives, 1976) or derived from the input/output matrix (as in Bachue), depending on whether it is a supply or a demand model.

[37] For guidelines on the preparation of such an inventory, see Bilsborrow (1974).

[38] The importance of sensitivity analysis was noted by Myrdal (1968); an early example is McFarland (1969).

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THE 1990 WORLD POPULATION AND HOUSING CENSUS PROGRAMME

*United Nations Secretariat**

SUMMARY

A population census is the primary source of demographic information for every country. In planning for the 1990 round of censuses, the international community has adopted a number of recommendations for changes for countries and regions to consider in planning for and carrying out their censuses. In particular, alternatives for the measurement of economic activity have been proposed in order to obtain a more realistic indication of employment and unemployment in countries where the agricultural and informal sectors are important. New recommendations have also been made for the measurement of stocks and flows of international migrants. In each of the major regions, recommendations have been adopted to meet specific local concerns. Preparations are being made for technical co-operation in the 1990 census round, and a calendar of the census dates in all countries is shown to be nearly complete.

INTRODUCTION

Population and housing censuses have been the most important source of data on the size, composition, characteristics and distribution of population. Another important source is the civil registration and vital statistics system, but continuous recording of vital events and the resultant vital statistics have been difficult to achieve in the developing countries. Thus, the completeness of coverage has suffered, and the statistics are still unreliable for many countries. National demographic surveys have also been undertaken by many countries to supplement the population data obtained from censuses and the vital statistics system, but such surveys are not designed to produce a continuous flow of demographic information. Therefore, in the near and medium-term future, developing countries will almost certainly continue to rely on censuses to meet their growing need for population statistics.

Recognizing the vital importance of censuses, in May 1985 the Economic and Social Council, on the recommendation of the Statistical

*Statistical Office, Department of International Economic and Social Affairs.

Commission,[1] adopted resolution 1985/8, entitled "1990 World Population and Housing Census Programme", in which it requested the Secretary-General to proceed with the development of a 1990 World Population and Housing Census Programme, to be carried out during the period 1985-1994, and to make all the necessary preparations with a view to assisting interested Member States in planning and carrying out improved censuses during the 1990 census decade.

The present paper sets forth the preparations so far made or planned by the Statistical Office (DIESA), the regional commissions and various countries to carry out a population and housing census in the 1990 round. It also presents the census calendar, showing dates of national population and/or housing censuses taken or anticipated during the decade 1985-1994 (see annex).

Substantive preparations for the 1990 World Census Programme

Global level

As part of its preparations for the World Programme, the Statistical Office convened an Expert Group on the 1990 World Population and Housing Census Programme in New York in November 1985. The Expert Group focused especially on possible supplementary principles and recommendations needed for the 1990 round of population and housing censuses.[2] The experts agreed that the existing global recommendations published in *Principles and Recommendations for Population and Housing Censuses* (Series M, No. 67)[3] remained largely valid, and they examined in detail the census topics that required supplementary recommendations in light of recent developments and data needs in the economic and social sectors.

Economically active population

The first of the recent developments was the adoption in 1982 by the Thirteenth International Conference of Labour Statisticians of a resolution setting forth new standards concerning statistics on the economically active population.[4] The new standards replace those adopted in 1954, which were used by most countries in the 1960, 1970 and 1980 rounds of population censuses. The 1954 standards, also known widely as the labour-force approach, were found to yield quality data for industrialized countries and organized sectors of the economy. Experience of developing countries in utilizing the 1954 standards has, however, been unsatisfactory for several reasons. First, the concept of seeking employment has not been suited to the agricultural and informal sectors that characterize many developing economies. In many areas people have to create for themselves some work to make a living, since they are neither fully employed nor fully unemployed. Secondly, the economic role of women has been not captured fully and therefore the measurement of female labour-force participation, particularly as unpaid family workers, has been subject to a wide margin of error. In order to deal with these conditions in developing countries, modification of the 1954 standards became necessary, and efforts have been made to reformulate the labour-force concepts. Those efforts were focused on the measurement of underemployment or time utilized for work and on new criteria for measuring unemployment.

Taking note of the above limitations in the 1954 standards, the new resolution presents two measures of the economically active population—namely, the "usually active population", measured in relation to a long reference period such as a year, and the "currently active population", or the labour force measured in relation to a short reference period such as one week or one day. Countries may choose to adopt either the usually active measure or the currently active measure (i.e., the labour force), or both.[5] The active population is, in turn, defined to comprise all persons "employed" and "unemployed" during the relevant reference period.

Under the new resolution, the employed are divided into two categories:

(*a*) those in paid employment—that is, persons who, during the reference period, performed some work for a wage or salary in cash or in kind;

(*b*) those in self-employment—that is, persons who, during the reference period, performed some work for profit or family gain in cash or in kind.

The new standards include among the self-employed persons engaged in the production of goods and services for their own and household consumption, since such production comprises an important contribution to the total consumption of the household in the developing countries. In addition, the new resolution considers unpaid family workers as self-employed irrespective of the number of hours worked during the reference period. In the previous approach, unpaid family workers were not counted among the employed unless they had worked for at least one-third of a normal working period. This new approach will more fully reflect the economic contribution of women.

In the new resolution, the unemployed includes all persons above a specified age who are:

(*a*) "without work"—that is, not in paid employment or self-employment, as defined above, during the reference period;

(*b*) "currently available" for work—that is, available for paid employment or self-employment during the reference period;

(*c*) "seeking work"—that is, having taken specific steps in a specified recent period to seek paid employment or self-employment; the specific steps may include, *inter alia,* registration at employment exchanges; application to employers; checking at work sites, farms, factory gates or other assembly places; seeking the assistance of friends or relatives; looking for land, building, machinery or equipment to establish an enterprise; arranging for financial resources; and applying for permits and licenses.

Thus, the new resolution is more suited to work conditions in developing countries because it stresses seeking or availability for self-employment as well as paid employment.

International migration

The second development concerns statistics on international migration. At its nineteenth session, the Statistical Commission adopted a set of

recommendations on international migration statistics,[6] and at its twenty-first session in 1981 it generally endorsed a strategy for implementing the recommendations relating to immigrant stock data and migrant flow statistics.[7] Accordingly, as recommended by the Expert Group, the Statistical Office, in co-operation with the International Labour Office, regional commissions and other organizations, prepared the "Draft supplementary recommendations for population and housing censuses" (ST/ESA/STAT/SER.M/67/Add.1), which were adopted by the Statistical Commission at its twenty-fourth session, in February 1987,[8] for publication and wide distribution to countries, under the title *Supplementary Principles and Recommendations for Population and Housing Censuses.*

The immigrant stock of a country is defined as all foreign-born persons present in the country for more than one year, and the principal source of data on them is the national census. It has been recommended that the immigrant stock include only those foreign-born in residence for a year or more, in order to be consistent with the concept of long-term immigrant or emigrant. Consequently, a country's immigrant stock at the census date would be composed of the survivors of all long-term immigrants who had entered the country more than one year prior to the census date. Therefore, in association with the question on place or country of birth, an additional question concerning the year or period of arrival in the country is recommended in order to measure immigrant stock exactly as defined above. Lacking such a question, it has been recommended that the total foreign population enumerated in censuses be taken as a close approximation to the immigrant stock. Further, in order that immigrant stock data are useful to both immigration and emigration countries and in order to enhance the comparability of such data, a common set of tabulations has been recommended for compilation by all countries.[9]

Regional level

Since 1985, a number of preparatory and related activities have also taken place or are in preparation at the regional level for the 1990 census round. For example, in the case of the reports of the Economic Commission for Europe (ECE), a series of informal meetings were used as the basis for draft recommendations for the 1990 round of population and housing censuses in the region (i.e., the regional variant of the world recommendations referred to above). The draft recommendations were reviewed by the Meeting on Population and Housing Censuses held at Geneva in 1987. The recommendations were completed and endorsed in 1987 by the Conference of European Statisticians and by the Committee on Housing, Building and Planning for publication and use by ECE countries.

With respect to the economically active population, the ECE recommends that countries give preference to collecting information on the basis of the current-activity concept (i.e., the labour-force concept) rather than on the basis of the usual-activity concept. A time reference period of one week has been recommended. However, it was recognized that some countries in the region may prefer to collect information on the basis of the usual activity instead, in which case a reference period of 12 months should be used. In addition, the ECE recommendations point out the value,

for a number of purposes, of having information on both current and usual activity, while recognizing the difficulty of including both concepts in censuses. Thus, countries using the labour-force concept were urged to obtain supplementary data covering at least a count of persons who were usually economically active during a specified 12-month period. Likewise, countries using the concept of usual activity were urged to obtain supplementary data covering at least the size of the labour force during a one-week period.

The Economic and Social Commission for Asia and the Pacific (ESCAP) also organized two working groups on the 1990 World Population and Housing Census Programme, one for Asian countries, in Bangkok in November 1986, and the other for the Pacific countries, in Rarotonga in June 1987, to review national experiences in conducting the 1980 round of population and housing censuses and consider Asian and Pacific recommendations for the 1990 censuses.[10]

The Working Group concluded that, even though the use of both usual- and current-activity concepts adopted by the ILO in a population census were useful for various purposes, it would be difficult to collect data using both approaches in most countries, because of the expense, limitations of questionnaire space and the heavy burden of coding and processing. Instead it was recommended that the interrelationship between the concepts be studied through carefully designed post-censal employment/unemployment surveys. Further, in areas where the old and new ILO standards differed significantly, a sample survey could be used to collect data on both bases to permit a comparison of the economically active population at the previous and the 1990 censuses. For that purpose, greater probing would be necessary regarding the nature and hours of work by unpaid family workers, and also for persons without work. The census economic questionnaire would need adequate pre-testing, especially for questions being introduced for the first time.

In addition, the ESCAP Working Group directed attention to the census as a potential source of more accurate data on internal migration. In discussing migration topics, the Working Group felt that place of usual residence *n* years was the most useful. While, for some purposes, the reference period of one year ago was preferred, on balance, a longer period such as five years or the time since the last census was considered most useful, since it permitted a larger pool of migrants to be captured. The Working Group also recommended the inclusion of birthplace as a useful variable to measure migration.

The Economic Commission for Africa (ECA) held a Working Group on Recommendations for the 1990 Round of Population and Housing Census Programme in Africa in May 1987 at Addis Ababa. The Working Group stressed that population and housing censuses need to be carried out at regular intervals. Thus, African countries should endeavour above all to maintain a decennial census programme. It recommended, *inter alia,* that census statistical offices prepare comprehensive programmes for census cartographic work,[11] ensure adequate training and selection of staff and institute a more formal system of quality control of the various census operations, particularly census enumeration. Special attention should be given to the measurement of economic activity in rural areas, in the infor-

mal sector and among women, and tabulations should be produced with respect to various economic characteristics such as age, sex and educational level. Also, efforts should be made to place the final census results at the disposal of users within the two years or, at the latest, the three years following the enumeration, and care should be taken to avoid over-correction of data, which might lead away from reality. Finally, to enhance the dissemination and utilization of census results, the Working Group recommended that national seminars and, if possible, regional or topical seminars[12] be organized, thereby providing an opportunity for dialogue between data users and producers.

In the region served by the Economic Commission for Latin America and the Caribbean (ECLAC), a number of census meetings took place to evaluate the 1980 censuses and examine factors special to the region in order to make further improvements in the quality and coverage of the census. In particular, a regional seminar was held in October 1986 at Buenos Aires on measuring the economic characteristics in population and housing censuses.[13] Emphasis was placed on improving measurement of the economic activity of women.

In November 1985, the Economic and Social Commission for Western Asia (ESCWA) convened a Regional Seminar on World Population and Housing Censuses at Baghdad.[14] The Seminar reviewed and examined the methods and procedures applied by member countries in carrying out their census programmes. It also discussed some of the basic issues emerging from past censuses in the region. The new standards adopted by the International Labour Organisation were found to be important developments, and it was agreed they would be given further consideration for use in the 1990 round of censuses. The topic of international migration was also stressed as important for the region.

National level

A number of countries besides those that traditionally conduct a mid-decade census have already taken a census for the 1990 round. The mid-decade census has undoubtedly helped countries to maintain a continuous census capability. It results in an updating of the census household lists every five years and contributes to other statistical operations, such as household surveys, and to a generally higher quality of population and housing censuses and post-censal estimates and projections. The countries that have already carried out a census since 1985 are shown in the annex.

Several countries have organized seminars or workshops for evaluating coverage and other errors in the 1980 censuses and on utilization of census data, including preparations of national population and related projections. In some countries they were organized in the context of reviewing past experiences and planning for the 1990 round of population and housing censuses.

Countries with a long tradition and permanent machinery for census-taking have already begun planning for the 1990 census round. A number of countries intend to introduce audio-visual aids for the training of enumerators. That innovation should help to minimize the loss of quality in training from one level to the next. Many countries are planning to take

advantage of advances in microcomputer technology to process census data expeditiously and publish them for timely utilization. Generally, countries are placing more emphasis on careful planning and training to improve the quality and coverage of the 1990 round of censuses.

Census training and other technical co-operation activities for 1990 censuses

In preparation for the 1980 round, census-training workshops and seminars were organized by the United Nations at the regional level for training nationals of developing countries. In many developing countries, census personnel had little experience in census-taking. Therefore, the topics covered in the workshops were very basic in nature. They included the organization of the census office, fundamental concepts and definitions, census topics and questionnaire design, field organization, enumerator training and supervisory controls. The workshops also covered elementary aspects of census cartography, the use of sampling in censuses and data-processing topics considered to be somewhat more specialized in nature.

In addition to the training given in workshops, census personnel from many developing countries also received census training in other direct and indirect ways. For instance, training was imparted through day-to-day guidance given on the job by experienced national and international advisers who were assigned to the census offices and through fellowships awarded by various organizations for formal training in institutions or study tours in advanced countries. The substantial gain in knowledge acquired by those means enabled personnel of many developing countries to increase their basic technical capability for census operations.

For the 1990 censuses fewer countries will need basic training in general census topics. An appraisal of needs should, however, take into account the high turnover of staff with census experience in a number of developing countries, particularly in the ECA and ESCWA regions. On the other hand, many developing countries need training workshops and seminars in specialized topics such as software applications for data analysis.

The 1990 recommendations focus on the collection of improved census economic statistics in line with new ILO standards concerning the measurement of the economically active population. It has been proposed to organize a series of specialized training workshops on the subject, in collaboration with ILO. The workshops will deal with the new standards and revised international classifications of occupation and industry and their use in the 1990 censuses.

A large census-training programme for the sub-Saharan African region has been approved by the United Nations Population Fund (UNFPA), with funds generously provided by the Canadian International Development Agency (CIDA). The programme has been in operation since 1987 and is carried out by the Department of Technical Co-operation for Development (DTCD), United Nations Secretariat, with the substantive support of the Statistical Office and the Economic Commission for Africa (ECA). The immediate objectives of the training programme are to train census personnel in countries of sub-Saharan Africa in various census activities and to strengthen the capacity of national census departments or

offices with respect to human resources and census methodologies. The programme has three components:

(*a*) international fellowships in universities and other advanced research institutions;

(*b*) national training courses in census-taking and data-processing, including the preparation of training documents;

(*c*) sub-regional training workshops in census cartography and data analysis.

The training programme will be carried out during 1987-1992 and is expected to train approximately 750 census personnel from about 35 countries in the region.

Other technical co-operation activities include the provision of technical advisory services through country, regional or interregional advisers; the provision of training through workshops, fellowships and study tours; and the provision of funds for the purchase of equipment. Those forms of technical co-operation have been supported by UNFPA and, within the Secretariat, were executed by the Department of Technical Co-operation for Development, with substantive support from the Statistical Office and regional commissions. The substantive support from the Statistical Office has in recent years been carried out on a shared basis by the technical and interregional advisers and the regular programme staff. In addition, the regional commissions have usually had one or more regional advisers, and in ECA there was also a regional adviser on census/survey cartography. Those advisory services could be drawn on by the countries in the region. In connection with the 1990 World Population and Housing Census Programme, those activities are expected to continue, subject to availability of funds.

NOTES

[1] *Official Records of the Economic and Social Council, 1985, Supplement No. 6* (E/1985/26), chap. I, sect. A; and chap. VII, sect. B.

[2] For details, see "Report of the Expert Group on the 1990 World Population and Housing Census Programme" (ESA/STAT/AC/24/15).

[3] United Nations publication, Sales No. E.80.XVII.8.

[4] See *General Report of the Thirteenth International Conference of Labour Statisticians, 18-29 October 1982* (Geneva, International Labour Office, 1982): resolution I, "Concerning statistics of the economically active population, employment, unemployment and underemployment".

[5] In all, 20 tabulations are recommended, covering the size, age, sex, marital status, occupation, industry, status in employment and educational characteristics of the employed and unemployed population. For a detailed list of economic tabulations, see United Nations, *Supplementary Principles and Recommendations for Population and Housing Censuses*, chap. I (forthcoming).

[6] *Recommendations on Statistics of International Migration* (United Nations publication, Sales No. E/79.XVII.18) and report of the Secretary-General on a strategy for implementation of recommendations on international migration statistics (E/CN.3/549), para. 22.

[7] *Official Records of the Economic and Social Council, 1981, Supplement No. 3* (E/1981/13), para. 122.

[8] *Official Records of the Economic and Social Council, 1987, Supplement No. 6* (E/1987/19), para. 124.

[9] The following common tabulations are recommended: (*a*) immigrant stock by period of arrival, country of birth, age and sex; (*b*) immigrant stock by marital status, age and sex (cross-classification by country of birth also useful); (*c*) immigrant stock *x* years of age and over by usual (or current) activity status, age and sex; (*d*) economically active immigrant stock *x* years of age and over by period of arrival, occupation and sex (cross-classification by country of birth also useful); (*e*) immigrant stock *x* years of age and over by educational attainment, age and sex.

[10] Economic and Social Commission for Asia and the Pacific, "Report of the Regional Working Group on the 1990 World Population and Housing Census Programme (STAT/WPHCP/14); report of the ESCAP/SPC Pacific Working Group on the 1990 World Population and Housing Census Programme, June 1987.

[11] Economic Commission for Africa, "Summary of supplementary recommendations for African population and housing censuses" (May 1987).

[12] Seminars on topics such as regional development, education, health and housing.

[13] Informe Tecnico del Seminario Regional sobre Características Económicas de la Población de los Census de 1990 (Buenos Aires, October 1986).

[14] Economic and Social Commission for Western Asia, "Final report and recommendations of the Regional Seminar on Population and Housing Censuses in the ESCWA Region" (E/ESCWA/STAT/85/WG/1/2).

ANNEX

Dates of national population and/or housing censuses taken during the 1975–1984 decade and taken or anticipated during the 1985–1994 decade[a]

Country or area	1980 round		1990 round	
	1975–1979	1980–1984	1985–1989	1990–1994
Africa				
Algeria	12 II 1977 PHA	—	IV 1987 PH	—
Angola	—	II 1983 PHA[b]	....	(....)
Benin	20 III 1979 PHA	—	1989 PH *	....
Botswana	—	12-26 VIII 1981 PHA	....	(1991 P)
Br. Indian Ocean Terr.[c]	—	—	....	....
Burkina Faso	1-7 XII 1975 P A[d]	—	10-20 XII 1985 P A	—
Burundi	15/16 VIII 1979 P A	—	1989 PH *	....
Cameroon	9 IV 1976 PHA	—	(....)	....
Cape Verde	—	1/2 VI 1980 PHA	—	1990 PH *
Central African Republic	8-22 XII 1975 P A[e]	—	XII 1988 PH *	....
Chad[f]	—	—	....	(1991 P)
Comoros	—	15 IX 1980 PHA	(....)	(....)
Congo	—	22 XII 1984 PHA	....	(1994 P)
Côte d'Ivoire	30 IV 1975 P A	—	2 XI 1987 PHA	—
Djibouti	—	3 I 1983 P A	....	(....)
Egypt	22/23 XI 1976 PHA	—	18 XI 1986 P	—
Equatorial Guinea	—	VII 1983 P A	....	(....)
Ethiopia	—	9 V 1984 PHA	....	(....)
Gabon	—	1-31 VIII 1981 P A	....	(....)
Gambia	—	24 IV 1983 PHA	....	(1993 P)
Ghana	—	18 III 1984 P A	....	(....)
Guinea	—	4-17 II 1983 P A	....	(....)
Guinea-Bissau	16 IV 1979 PHA	—	(....)	....
Kenya	25 VIII 1979 P A	—	1989 P *	....
Lesotho	12 IV 1976 P A	—	12 IV 1986 P	—
Liberia	—	1-14 II 1984 PHA	....	(1994 P)

Country or area	1980 round		1990 round	
	1975–1979	1980–1984	1985–1989	1990–1994
Africa (cont.)				
Libyan Arab Jamahiriya	—	31 VII/1 VIII 1984 P A	....	(....)
Madagascar	1974/1975 PHA[g]	—	....	(1990 P)
Malawi	20 IX-10 X 1977 P A	—	1-21 IX 1987 PHA	—
Mali	1-16 XII 1976 P A	—	1-30 IV 1987 PHA	—
Mauritania	1 I 1977 P A[h]	—	1 IV 1988 PHAT	—
Mauritius	—	2 VII 1983 P A	....	(....)
	—	III-IV 1983 H	....	(....)
Morocco	—	2/3 IX 1982 PHA	....	(....)
Mozambique	—	1 VIII 1980 P A	....	(1990 P)
Namibia[i]	—	—	....	....
Niger	20 XI 1977 P A[j]	—	28 V-3 VI 1988 PHAT	—
Nigeria[k]	—	—	—	1991 P *
Réunion	—	9 III 1982 P	10-24 V 1988 PHA*	....
Rwanda	15/16 VIII 1978 PHA	—	(VIII 1989 P)	....
St. Helena	31 X 1976 PH	—	22 II 1987 PH	—
Sao Tome and Principe	—	15 VIII 1981 PHA	....	(....)
Senegal	16 IV 1976 P A	—	20 V-5 VI 1988 PHT	—
Seychelles	1 VIII 1977 P	—	(....)	....
Sierra Leone[l]	—	—	1 XII 1985 PHA	—
Somalia	7 II 1975 P A[m]	—	II 1987 PHA	—
South Africa	—	6 V 1980 PH	5 III 1985 PH	(1990 P)
Sudan	—	1 II 1983 PHA	....	(1993 P)
Swaziland	25/26 VIII 1976 P A	—	25 VIII 1986 PH	—
Togo	—	22 XI 1981 PHA	....	(....)
Tunisia	8 V 1975 PHA	30 III 1984 PH	....	(....)
Uganda	—	18 I 1980 PHA	....	(....)
United Rep. of Tanzania	26/27 VIII 1978 P	—	28 VIII 1988 PT	—
Zaire	—	1 VII 1984 P A	....	(....)
Zambia	—	25 VIII 1980 PHA	—	1990 P *
Zimbabwe	—	18 VIII 1982 P A	—	1992 P *

America, North				
Anguilla	—	1984 P	....	....
Antigua and Barbuda	—	1 V 1982 H	....	....
Aruba[n]	—	1 II 1981 PH	....	(....)
Bahamas	—	12 V 1980 P	....	(1990 P)
Barbados	—	12 V 1980 P A	....	(1990 P)
Belize	—	12 V 1980 P A	....	(1990 P)
Bermuda	—	12 V 1980 P	....	(1990 P)
British Virgin Islands	—	12 V 1980 P A	....	(1990 P)
Canada	1 VI 1976 PH	3 VI 1981 P	3 VI 1986 PH	(VI 1991 PH)
Cayman Islands	8 X 1979 PHA	—	(....)	....
Costa Rica	—	10 VI 1984 PHA	....	(....)
Cuba	—	11 IX 1981 PHA	....	(....)
Dominica	—	7 IV 1981 P A	....	(....)
Dominican Republic	—	12 XII 1981 PHA	....	(....)
El Salvador[o]	—	—	....	....
Greenland	26 X 1976 PH	—	(....)	....
Grenada	—	30 IV 1981 P A	(....)	(....)
Guadelupe	—	9 III 1982 PH	(1989 PH)	....
Guatemala	—	23 III 1981 PHA	—	(IV 1990 PH)
Haiti	—	30 VIII 1982 PHA	....	(....)
Honduras[p]	—	—	V 1988 PHA*	...
Jamaica	—	8 VI 1982 P A	....	(....)
Martinique	—	9 III 1982 PH	(1989 PH)	....
Mexico	—	4 VI 1980 PH	....	(1990 PH)
Montserrat	—	12 V 1980 P A	....	(1990 P)
Netherlands Antilles[n]	—	1 II 1981 PH	....	(....)
Nicaragua[q]	—	—	....	....
Panama	—	11 V 1980 PH	....	(1990 P)
Puerto Rico	—	1 IV 1980 PH	....	(1990 P)
Saint Kitts and Nevis	—	12 V 1980 P A	....	(1990 P)
Saint Lucia	—	12 V 1980 P A	....	(1990 P)
St. Pierre and Miquelon	—	9 III 1982 PH	(1989 PH)	....
Saint Vincent and the Grenadines	—	12 V 1980 P A	....	(1990 P)
Trinidad and Tobago	—	12 V 1980 P A	....	(1990 P)

Country or area	1980 round		1990 round	
	1975–1979	1980–1984	1985–1989	1990–1994
Turks and Caicos Islands	—	12 V 1980 P A	....	(1990 P)
United States of America	—	1 IV 1980 PH	—	1990 PH*
U.S. Virgin Islands	—	1 IV 1980 PH	....	(1990 PH)
America, South				
Argentina	—	22 X 1980 PH	....	(1990 PH)
Bolivia	29 IX 1976 PHA	—	(....)	....
Brazil	—	1 IX 1980 P	....	(1990)
		1 I 1981 H	....	....
Chile	—	21 IV 1982 PH	....	(....)
Colombia[r]	—	—	X 1985 PH	—
Ecuador	—	28 XI 1982 PH	....	(....)
Falkland Is. (Malvinas)	—	7 XII 1980 P	(....)	(....)
French Guiana	—	9 III 1982 PH	(1989 PH)	....
Guyana	—	12 V 1980 PHA	....	(1990 P)
Paraguay	—	11 VII 1982 PHA	....	(1992 P)
Peru	—	12 VII 1981 PHA	....	(....)
Suriname	—	1 VII 1980 PHA	....	(....)
Uruguay	21 V 1975 PHA	—	23 X 1985 P	—
Venezuela	—	20 X 1981 PH	....	(1991 PH)
Asia				
Afghanistan	23/24/VI 1979 PHA[s]	—	(....)	....
Bahrain	—	5 IV 1981 PHA	—	1991 P *
Bangladesh	—	6/7 III 1981 PHA	—	1991 PH *
Bhutan	—	I 1980-I 1981 P	....	(....)
Brunei Darussalam	—	26 VIII 1981 PHA	....	(1991 P)
Burma	—	31 III 1983 P A	....	(1993 P)
China	—	1 VII 1982 P A	—	1990 PH *
Cyprus	30 IX 1976 P [t]	1 X 1982 P	....	(....)
Democratic Kampuchea[u]	—	—	....	....
Democratic Yemen[v]	—	—	29/30 III 1988 PHA*	....

East Timor	—	31 X 1980 P	....		(....)
Hong Kong	2 VIII 1976 PH	9 III 1981 PH	III 1986 PH	w	1991 PH *
India	—	1 III 1981 P	—		1991 P *
	—	1980 H	—		1990 H *
Indonesia	—	31 X 1980 PHA	—		1990 PH *
Iran, Islamic Republic of	30 X-19 XI 1976 PHA	—	IX-XI 1986 PH		
Iraq	17 X 1977 PH	—	(....)		....
Israel	—	4 VI 1983 PH	....		(....)
Japan	1 X 1975 P	1 X 1980 P	1 X 1985 P		1 X 1990 P *
	1 X 1978 H	1 X 1983 H	(1 X 1988 H)		(1 X 1993 H)
Jordan	10/11 XI 1979 PHA	—	1989 PH *		....
Korea, Dem. People's Rep.[x]	—	—	....		....
Korea, Republic of	1 X 1975 PH	1 XI 1980 PH	1 XI 1985 PH		1990 PH *
Kuwait	20/21 IV 1975 PHA[y]	IV 1980 PHA	21 IV 1985 PHA		(1990 PH)
Lao People's Dem. Rep.	1 II-31 III 1975 PHA[z]	—	1 III 1985 P A		—
Lebanon[aa]	—	—	....		....
Macau	—	16 III 1981 PH	....		(....)
Malaysia	—	10 VI 1980 PH	—		1990 PH *
Maldives	31 XII 1977 PHA	—	25-28 III 1985 PHA		1990 PH *
Mongolia	5 I 1979 PHA	—	(....)		....
Nepal	—	22 VI 1981 P A	....		(1991 P)
Oman	[bb]	—	....		....
Pakistan	—	1 III 1981 P A	—		1991 P *
	—	XII 1980 HA	—		1990 H *
Palestine[cc]	—	—	....		....
Gaza Strip[dd]	—	—	....		....
Philippines	1-10 V 1975 P A	1 V 1980 PHA	—		1990 PH *
Qatar[ee]	—	—	16 III 1986 PH		—
Saudi Arabia[ff]	—	—	....		....
Singapore	—	24 VI 1980 PH	—		1990 PH *
Sri Lanka	—	17 III 1981 PHA	—		1991 PH *
Syrian Arab Republic	—	8 IX 1981 PHA	....		(1991 PH)
Thailand	—	1 IV 1980 PHA	—		1990 PH *
Turkey	26 X 1975 PH	12 X 1980 P A	20 X 1985 PH		(1990 P)

Country or area	1980 round		1990 round	
	1975-1979	1980-1984	1985-1989	1990-1994
Asia (cont.)				
United Arab Emirates	31 XII 1975 PHA	15 XII 1980 PHA	17-23 XII 1985 PH	1990 PH *
Viet Nam	1 X 1979 P A	—	IV 1989 PHA*	....
Yemen	1 II 1975 PHA	—	1-18 II 1986 PHA	—
Europe				
Albania	7 I 1979 P	—	(....)	....
Andorra	1 II 1975 P	—	(....)	....
Austria	—	12 V 1981 PH	—	1991 PH *
Belgium	—	1 III 1981 PH	....	(1991 PH)
Bulgaria	2 XII 1975 PH	—	4 XII 1985 PH	—
Channel Islands	—	5 IV 1981 PH	23 III 1986 P	(1991 PH)
Czechoslovakia	—	1 XI 1980 PH	....	(1990 PH)
Denmark	—	1 I 1981 PH	....	(1991 PH)
Faeroe Islands	22 IX 1977 PH	—	(....)	....
Finland	31 XII 1975 PHgg	1 XI 1980 PH	17 XI 1985 PH	1990/1991 PH *
France	20 II 1975 PH	4 III 1982 PH	(1989 PH)	....
German Democratic Rep	—	31 XII 1981 PH	....	(1991 PH)
Germany, Federal Rep. of	—	—	25 V 1987 PH	—
Gibraltar	—	9 XI 1981 PH	....	(1991 PH)
Greece	—	5 IV 1981 PH	....	(1991 PH)
Holy See	hh	hh	hh	....
Hungary	—	1 I 1980 PH	—	1 I 1990 PH *
Iceland	ii	ii	ii	....
Ireland	1 IV 1979 P	5 IV 1981 PH	...	(....)
Isle of Man	4/5 IV 1976 PH	5/6 IV 1981 PH	6/7 IV 1986 PH	(1991 PH)
Italy	—	25 X 1981 PH	....	(1991 PH)
Liechtenstein	—	2 XII 1980 PH	....	(1990 PH)
Luxembourg	—	31 III 1981 PH	....	(1991 PH)
Malta	—	—	16 XI 1985 P	—
Monaco	1 II 1975 PH	4 III 1982 PH	(1989 PH)	....
Netherlandsii	—	—	—	—
Norway	—	1 XI 1980 PH	....	(1990 PH)
Poland	7 XII 1978 PH	—	(....)	....

Portugal	—	16 III 1981 PH	....	(1991 PH)
Romania	5 I 1977 PH	—	(....)	....
San Marino	30 XI 1976 PH	—	(....)	....
Spain	—	1 III 1981 PH	....	(1991 PH)
Svalbard and Jan Mayen Is.[kk]	—	—	—	—
Sweden	1 XI 1975 PH	15 IX 1980 PH	1 XI 1985 PH	1 XI 1990 PH *
Switzerland	—	2 XII 1980 PH	....	(1990 PH)
United Kingdom				
England and Wales	—	5/6 IV 1981 PH	....	(1991 PH)
Northern Ireland	—	5/6 IV 1981 PH	—	1991 PH *
Scotland	—	5/6 IV 1981 PH	....	(1991 PH)
Yugoslavia	—	31 III 1981 PH	....	(1991 PH)
Oceania				
American Samoa	—	1 IV 1980 PH	....	(1990 PH)
Australia	30 IV 1976 PH	30 VI 1981 PH	30 VI 1986 PH	VI 1991 PH *
Canton and Enderbury Is.[ll]	—	—	....	....
Christmas Island {Aust.}	—	30 VI 1981 PH	....	(1991 PH)
Cocos (Keeling) Islands	—	30 VI 1981 PH	....	(1991 PH)
Cook Islands	1 XII 1976 PHA	1 XII 1981 PH	(....)	(1991 PH)
Fiji	13 IX 1976 P A	—	31 VIII 1986 P	—
French Polynesia	29 IV 1977 P	15 X 1983 P	....	(....)
Guam	—	1 IV 1980 PH	—	1990 PH *
Johnston Island	—	1 IV 1980 P	....	(1990 P)
Kiribati	12/13 XII 1978 PH	—	9/10 V 1985 P	1990 PH *
Midway Islands[ll]	—	—	....	....
Nauru	22 I 1977 PH	—	(....)	....
New Caledonia	23 IV 1976 PH	15 IV 1983 P	....	(....)
New Zealand	23 III 1976 PH	24 III 1981 PH	4 III 1986 PH	1991 PH *
Niue	28/29 IX 1976 PH	28 IX 1981 PH	29 IX 1986 PH	(1991 PH)
Norfolk Island	—	30 VI 1981 PH	....	(1991 PH)
Pacific Islands	—	15 IX 1980 PHA	(....)	1990 PH *
Papua New Guinea	—	22 IX-3 X 1980 P A	—	1990 P *
Pitcairn[mm]	—	—	....	....
Samoa	3 XI 1976 PHA	3 XI 1981 PHA	3/4 XI 1986 PH	(1991 PH)
Solomon Islands	7/8 II 1976 P	—	XI 1986 P	—

Tokelau	25 X 1976 PH	1 X 1982 P	1986 PH	(1992 P)
Tonga	30 IX 1976 PHA	[nn]	XI 1986 P	—
Tuvalu	27 V 1979 P A	—	1985 P	—
Vanuatu	15/16 I 1979 P A	—	20 I 1986 P [oo]	1989 P *
Wake Island[ll]	—	—	....	....
Wallis and Futuna Islands	26 III 1976 P	—	(....)	....
Union of Soviet Socialist Republics				
USSR	17 I 1979 P	—	I 1989 P *	—
Byelorussian SSR	17 I 1979 P	—	I 1989 P *	—
Ukrainian SSR	17 I 1979 P	—	I 1989 P *	—

NOTES:

The dates are given in the following form: Arabic numeral(s) for the days, followed by a roman numeral for the month, followed by the year.

Unless otherwise noted, the dates refer to complete (100 per cent) enumeration, even though some topics may have been investigated on a sample basis. Indications and symbols are used as follows:

date Official national census date.
date* Provisional national census date.
(date) Anticipated by the Statistical Office of the United Nations on the basis of established pattern of census-taking.
(....) A reasonable anticipation that a census will be held during the decade but with no established pattern on which to predict a date.
.... No basis for anticipation.
— No census taken.
P Population census.
H Housing census.
T The census was reported taken (only 1988).
A Provision by the United Nations of a resident technical expert or financial assistance.

[a]The date of the population and/or housing census for each country or area that participated in the 1980 Programme, and the actual date for each country or area that has already conducted a population census in the 1990 Programme or the anticipated date for each country or area for which it can be assumed that a census is likely to be held before the end of 1994.

[b]A population census only for the Province of Luanda.

[c]A population census of the Chagos Archipelago was conducted 30 June 1962; a census of Aldabra, Farquhar and Des Roches was conducted 4 May 1970.

[d]In other sources the dates 1-10 December are found.

[e]Some results of estimations refer to 15 December 1975.

[f]An administrative census was conducted in March 1968.

[g]For provisional capitals, 1 December 1974; for Antananarive and remaining urban areas, 17 February 1975; for rural areas, 1 June 1975.

[h]Enumeration of sedentary population 22 December 1976–5 January 1977, and of nomads January–April 1977. In some publications 1 I 1977 is mentioned as census date.

[i]A census of population was conducted 6 May 1970. In an unofficial document a census of population is reported for 4 August 1981.

[j]Enumeration of northern nomads May and July 1977.

[k]A census of population was conducted 5-8 November 1963.

[l]A census of population was conducted 8 December 1974.

[m]Nomads were enumerated by sampling.

[n]Aruba has not been part of the Netherlands Antilles since 1 I 1986.

[o]A census of population was conducted 28 June 1971.

[p]A census of population was conducted 6 March 1974.

[q]A census of population was conducted 20 April 1971.

[r]A census of population was conducted 24 October 1973.

[s]The census of housing was conducted in urban areas only.

[t]A micro census of population was carried out 1 April 1973. Another population census was reported taken in September 1976. The coverage of both censuses is unknown.

[u]A census of population was conducted 17 April 1962.

[v]A census of population was conducted 14 May 1973.

[w]The 1986 population by-census was based on a one-in-seven sample of the population.

[x]A census of population was conducted 1 May 1944.

[y]A census of housing was conducted in March.

[z]Partial census, covering the city and plain of Vientiane, the cities of Luang-Prabang, Houeisai, Sayeboury, Savannakhet and Pakse.

[aa]A sample survey of population was conducted 8 November 1970.

[bb]A sample survey of population was conducted in 5 towns in April 1975 and in 11 towns and some rural areas in 1978.

[cc]A census of population was conducted 18 November 1931.

[dd]A census of population was conducted 14 September 1967.

[ee]No census of population was conducted.

[ff]A census of population was conducted 9-14 September 1974.

[gg]Questionnaires were pre-printed with answers obtained from various registers, such as the Central Register of Population, the Register of Completed Education (1980) etc., and the respondents were required to correct any inaccurate information.

[hh]No formal census was conducted. Population figures are compiled regularly from administrative records.

[ii]Annual population figures have been available from the National Registry since 1961.

[jj]A census of population was conducted 28 February 1971.

[kk]A census of population was conducted 1 November 1960. Inhabited only during winter session.

[ll]No formal census was conducted. Population figures were compiled on 1 April 1980 from administrative records. A census of population was conducted 1 April 1970.

[mm]No formal census was conducted. A count of numbers of each family group by name, sex, age and whether permanent or expatriate resident is made on 30 or 31 December each year.

[nn]For 30 November 1984 a mini-census of population, with seven questions, was reported.

[oo]Urban census.

PROMOTING FAMILY PLANNING FOR BETTER HEALTH: POLICY AND PROGRAMME IMPLICATIONS*

*Stephen Isaacs*** and Nuray Fincancioglu****

SUMMARY

Renewed emphasis is being given to the role of family planning in health-care programmes. This review of the lessons learned during the past decade provides guidance to policy-makers and programme managers on ways to improve maternal, infant and child health through family planning and related health and development activities. It covers policies and laws, accessibility to services, acceptability and quality of services, provision for the special needs of high-risk groups, the use of communications programmes, the importance of improving the status of women and the quality of life, and the resources needed to implement such a programme globally. Practical steps for integrating family planning fully into maternal and child health care are described.

The importance of family planning to the health of women and children has been recognized for many years. Almost every Government now supports family planning as a health measure. Nevertheless, re-emphasizing the place of family planning in health policies and programmes is particularly timely: the extent of maternal death is now widely understood, and measures to reduce it by improving pre-natal, maternal and post-partum care have become international health priorities. Child survival and primary-health-care strategies have achieved an important place in the provision of health services. At the same time, the weakened economies of many developing countries are forcing Governments to cut back services and to search for more cost-effective measures of providing health care. Evidence from cross-national studies and field experience shows that the unacceptable death toll of 500,000 women every year from causes related to pregnancy and childbirth could be halved by the year 2000 by a balanced programme of family planning and improved maternal health care. And a great many child deaths could be prevented if all pregnancies were well-timed and -spaced.[1]

*Based on a paper prepared for the International Conference on Better Health for Women and Children through Family Planning, held at Nairobi, Kenya, 5-9 October 1987.

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This paper addresses the question of how planners, policy-makers and managers of both governmental and non-governmental programmes can improve maternal, infant and child health through family planning and related health and development activities. It reviews the lessons learned during the past decade and explores available policy and programme options. Although generalizations are made here based on experiences shared by different countries, it is recognized that policy and programme decisions depend on cultural, political and social conditions, institutional capabilities, financial resources and long-standing patterns of reproduction. The focus is on family-planning policies and programmes, recognizing that those are most appropriately a component of broader development, health and human-rights policies.

FAMILY-PLANNING POLICIES AND PROGRAMMES: A REVIEW

Family-planning programmes throughout the world differ markedly in terms of the quality and quantity of service, coverage of the population and the extent of their integration into the political and economic fabric of a country. They also differ in the extent to which they respond to the needs and perceptions of individuals, families and communities. Despite the differences, however, valuable lessons have been learned, particularly in the past decade, about making family-planning services and information available. They are examined below.

Policies and laws

Over the past decade, at least 50 Governments have issued policies or enacted laws favourable to family planning, which is viewed as a benefit to the health of women and children, a fundamental human right, a measure to prevent abortion or a measure to reduce high population growth rates.[2] Government support has taken the form of legislation, constitutional provisions, policy statements, court decisions, sections of national development plans, and ministerial regulations. There is considerable diversity in the way the countries in different regions approach family planning, as the analysis of laws and policies below indicates.

Asia has the longest history of family-planning policies and programmes, justified primarily as a means of reducing high population growth. East Asia, China, Hong Kong, Indonesia, the Republic of Korea, Singapore, Taiwan Province and Thailand have succeeded in reducing both fertility and mortality by the combined effects of strong family-planning policies and programmes (in some cases utilizing incentives); comparatively high educational, health and income levels (with the exception of China and Indonesia, where per capita GNP remains low); governmental ability to reach to the village level and involve the villagers; and "political will".[3] South Asian countries, too, have long-standing anti-natalist policies and programmes, often focusing on sterilization as the main method of controlling fertility. Sri Lanka and several Indian states have succeeded in reducing fertility and mortality, owing to the availability of fertility-regulation services, high educational levels (particularly among women) and wide access to and demand for public health services.[4] In some cases,

however, programmes designed to achieve demographic goals have not adequately taken into account the health and human rights of individual citizens.

In Latin America and the Caribbean, four countries (Guatemala, Ecuador, Mexico and Peru) have enacted constitutional provisions guaranteeing individuals the right to decide on the number and the spacing of their children or emphasizing the importance of responsible parenthood. Most Latin American/Caribbean countries support family planning in their development plans or health and population policies. Initially the support was based on family planning as a health measure or human right or to prevent abortion; more recently, some countries, such as Mexico, have promoted family planning as a way to reduce population growth.

Over the past 10 years, there has been a notable transformation in the attitude of sub-Saharan African leaders towards family planning. Although 12 countries, primarily francophone, still provide no support to family planning, at least 13 countries, including Kenya, Nigeria and Senegal, have issued policies or development plans that explicitly call for the initiation or expansion of family-planning services.[5] Certainly, throughout sub-Saharan Africa, periods of from two to three years between births, achieved by breast-feeding and abstinence, have become the common tradition. Such spacing appears to be diminishing, however, in urban areas, as breast-feeding declines. Two major challenges are to make contraception an acceptable alternative to the traditional birth-spacing practices, which are being eroded in Africa, and to halt or slow that erosion.

North Africa and the Middle East present a mixed picture. On the one hand, the policies of Egypt, Morocco, Tunisia and Turkey promote family planning through a variety of public and private channels, and in Algeria family planning is now a component of the national maternal and child health (MCH) programme. On the other hand, Saudi Arabia maintains an absolute ban on contraception. In general, the laws and policies of the Gulf States do not support family planning, whereas the countries of North Africa, with the exception of the Libyan Arab Jamahiriya, have either explicit or tacit policies favourable to family planning. There is concern, however, that the rise of Islamic fundamentalism will erode the gains made in countries with large Muslim populations.

Family-planning information and services are available in most of the developed world. In the United States, legislation in 1970 established a national family-planning programme, and a decision of the Supreme Court legalized abortion in 1973. Contraceptive services to minors and, in particular, abortion have come under severe attack recently from "right-to-life" advocates.

In Europe, many Governments are concerned about below-replacement fertility and aging populations. As a result, many Eastern European countries offer a range of financial incentives to encourage couples to have children, and some have enacted legislation making abortions more difficult to obtain. Many Western European countries (e.g., Belgium, France, Federal Republic of Germany) offer pro-natalist incentives such as large family allowances and generous maternity benefits. None the less, with few exceptions, national laws and policies continue to make family-planning services available on the grounds of health, women's rights or the right of individuals to control the size of their families.

The introduction and implementation of national family-planning policies has had a mixed history. In many countries, the commitment of political leaders has generated popular support in favour of family planning, which, in turn, has led to effective programme implementation. In other countries, raising family planning as a public policy issue has led to a reaction against it. In still other countries, national family-planning policies were passed, but political will and popular support were lacking and effective programmes were never mounted.

Although most Governments have signed international accords committing themselves to family planning, laws and regulations in many countries create barriers to the delivery of both family-planning and health services. For example, many francophone African countries retain legislation prohibiting the distribution and advertising of contraceptives. In many instances, trained field-workers are not allowed to distribute contraceptives and simple medicines, thus hampering both family-planning and primary-health-care programmes. The import duty on contraceptives remains high in many countries, and the practical problems of clearing them through customs can be an obstacle.

During the past decade there has been a trend to remove or reduce restrictions on voluntary sterilization and to clarify its legality in Europe, the United States and much of Asia, thus transforming what had previously been an issue of criminal law into a matter of individual health, welfare and choice. Yet throughout large parts of Africa, the Middle East and Latin America, the legal status of voluntary sterilization remains uncertain. The lack of clarity has made some practitioners reluctant to provide sterilization.

Many countries have taken measures to avoid later regret among patients and prevent abuse of sterilization services by assuring that truly informed consent has been obtained. Obtaining informed consent is critical for all health services. It means that the person to be served has given his or her consent after being adequately informed about the nature of the procedure or medication, its risks and its benefits and the alternatives to it.

Accessibility of family-planning services

Even in countries with well-established family-planning programmes, the search for newer and more effective channels for delivering services continues. A number of approaches have been utilized to increase the accessibility of contraceptive services and supplies. They are discussed below.

Offering family planning with child survival, maternal/child health, and other health programmes

Whether they are called "linked", "co-ordinated" or "integrated", there are strong ethical and programmatic justifications for combining family planning with other health-care services, as is done in most countries. In a few countries—notably Indonesia and Thailand—agriculture and other village development activities have been added to successful community-based contraceptive distribution programmes.

Ethically, to exclude family planning from a range of other services is to deprive individuals of their right to an important health measure. Programmatically, it is often more cost-effective to strengthen existing institutions which have responsibility for delivering health and related services than to create new categories of single-purpose workers. Particularly in rural areas, field-workers have been reluctant to provide contraceptives only; a wider range of health interventions eases their entry into the community.

In national schemes (such as in Mexico and Thailand) and field experiments under widely differing circumstances, well-run programmes combining basic health and family-planning services have improved women's and children's health. Similarly, single-purpose family-planning programmes in such countries as China, Colombia and Indonesia have succeeded in increasing family-planning acceptance and contributed, presumably, to improved health.

An analysis of programmes around the world does not indicate whether integrated or vertical programmes (at the delivery level) are superior, but suggests that the key question is how well programmes are planned, managed and evaluated.[6]

Given the ethical and programmatic considerations, it seems clear that family planning should be a component of every maternal/child health, child survival and primary-health-care programme, particularly in rural areas where services can be delivered by field-workers or community agents. And given the concern that a sensitive preventive measure such as family planning will be lost among other, more immediate curative-health needs, care needs to be taken that family planning remains a visible component of integrated services.

Providing community-based family-planning, health and development programmes

The use of non-physicians to deliver health and family-planning services is a key element in primary health care. Evidence amassed in national programmes and pilot projects amply demonstrates that auxiliary health workers—including agents based in the community—can serve effectively as the distributors of contraceptives and simple medicines.[7]

The earliest community agents were the barefoot doctors who delivered basic health care and family planning in China during the 1950s and 1960s. They were followed, in the 1970s, by the community-based distribution (CBD) programmes of two Latin American family-planning associations, those of Brazil and Colombia. Although it was in the past considered nearly revolutionary for non-physicians to deliver services, nowadays it is almost commonplace in the developing world, where there is a scarcity of physicians.

Non-physicians have proved able to deliver contraceptives, oral rehydration therapy, immunizations, nutritional supplements and education and other simple health interventions. With regard to the distribution of oral contraceptives, which has been perhaps the most controversial aspect of CBD programmes, world-wide experience has been positive. For example, nurses, midwives and pharmacists deliver oral contraceptives in Sri Lanka;

auxiliary nurses and auxiliary midwives do so in Thailand; nurses, midwives and barefoot doctors do so in China; and rural health promoters do so in Colombia. Evaluations have demonstrated that those categories of individuals can deliver services as safely and effectively as physicians.

After a decade of experience, the question is not whether non-physicians should be used to provide health and family-planning services at the village level but how to use them most effectively. Issues of selection, training, supervision, supply and evaluation of community workers are still crucial to successful programme implementation. Certain basic principles have been established—such as the need not to overload field-workers with too many tasks, the importance of careful training and frequent supervision and the need for a functioning logistics system, which can be employed according to the particular circumstances of the locality.[8]

An increased emphasis on community-based services does not spell the demise of the clinic. The great majority of medical services are provided through clinics or hospitals. In the area of preventive medicine—and family planning, particularly—the clinic serves a vital role as a referral point in case of problems or side-effects, as a depot for supplies, as a location for training activities and supervisory visits and as the place where particular interventions (for example, voluntary sterilization) can be offered.

The finding that non-physicians can deliver contraceptive services safely and effectively has implications for clinical-service programmes. In some countries, women are subjected to time-consuming and costly examinations and tests before they can receive contraceptives. A re-examination of those procedures in the light of experience gained in CBD programmes may reveal that they can be substantially reduced without sacrificing safety.

Making greater use of the private sector

In health, as in other areas of development, there is a growing tendency to emphasize the importance of the private sector. This is particularly opportune in family planning, where, in many countries, half or more of the clients have been receiving their supplies through commercial or other channels.[9]

In many, if not most, countries, there are three primary sources of health services and contraceptive supplies: the governmental public health services; a parastatal (quasi-governmental) system of health services; and the private sector, which consists of private physicians, health facilities and pharmacists, non-governmental organizations, such as the national family-planning associations affiliated with the International Planned Parenthood Federation (IPPF) or facilities operated by benevolent or religious organizations, and traditional practitioners.

Increased focus on the private sector for the provision of at least some portion of the overall health-care services is both necessary and desirable. It is necessary because the world economic situation has forced cuts in domestic public services, including health. It is desirable because the private sector may be more innovative and flexible than the Government and can reach certain segments of the population more effectively.

The past decade has provided some indications of the actions that can be taken to promote greater private-sector participation in family planning.

(*a*) Social marketing programmes utilize retail outlets such as pharmacies and small shops to sell contraceptives (generally condoms, other barrier methods and pills) at subsidized prices. They have succeeded in increasing contraceptive sales in countries as diverse as Bangladesh, Egypt, El Salvador, India and Jamaica.

(*b*) Family planning has been added to the health services offered by businesses and trade unions in such countries as India, Sri Lanka and Turkey.

(*c*) Greater use of private physicians, pharmacies and for-profit health facilities (such as health maintenance organizations) has been encouraged. In the Republic of Korea and Taiwan Province, for example, where private doctors are accessible to large numbers of people, they are paid a fee-for-service to provide most of the sterilizations and IUD insertions in the governmental programmes. Since most private physicians and health organizations are located in urban areas and serve middle- or upper-class clients, the Government and the non-profit private sector still retain the job of serving the harder-to-reach people living in rural areas and urban slums.

(*d*) Community pharmacies have been established in such countries as Bangladesh, Haiti and Honduras to overcome the frequent lack of treatment drugs in public health facilities. Their success depends on the willingness of villagers to pay for a relatively constant supply of drugs and supplies and the ability to keep them well stocked.

(*e*) Traditional birth attendants and other practitioners have been utilized as community family-planning agents with considerable success in some countries. Programmes in Mexico and Thailand have also used traditional practitioners such as healers, herbalists, spiritualists and community medicine-men.

(*f*) Non-governmental organizations (NGOs) have assumed a greater share of service and information. Only a few years ago, it had been assumed that once Governments adopted family-planning policies and programmes, there would be little need for private family-planning associations and other NGOs. This has turned out not to be the case. Many family-planning associations affiliated with IPPF, for example, have maintained a very visible role in service delivery. In such countries as Colombia, the FPA provides a significant portion of the family-planning services.

Acceptability and quality of services

Experience in many countries has demonstrated the need for health and family-planning services to be geographically accessible, culturally acceptable, humane and considerate.[10] Whether that is called "the user perspective" or "quality of care", it stresses the often-neglected human element. As Habicht and Berman have observed:

> "Technology is not the main problem limiting the spread of effective primary health care. The limiting factors are organizational. We must provide technically effective services on a large scale which are

widely accessible, fiscally affordable, yet humane enough to be acceptable to all who need them."[11]

There is evidence to suggest that the quality of both clinical and outreach services in many national programmes is poor.[12] A recent study in Nepal disclosed, for example, that lower-class women were reluctant to enter a family-planning clinic; they expected poor treatment, and they got it.[13]

Improving the acceptability and quality of services requires, in many cases, a change of attitude on the part of providers to use more client-oriented strategies. It implies treating clients with dignity and respect, being sensitive to their needs (and recognizing that needs are not static), and giving them sufficient information to make an informed choice. It may mean increased reliance on personnel other than physicians, since experience has shown that "medical personnel are not trained in communication or counselling techniques and often have neither the inclination nor the time to spend with clients discussing their needs, fears, and/or questions".[14]

Similarly, experience has shown that cultural mores must be respected and built upon. Health personnel and community agents should be acceptable to their clients; where it is culturally inappropriate for a woman to receive counselling from, or be examined by, a man, that practice should be avoided. A post-partum project in Tunisia, building on the traditional importance of the fortieth day after the birth of a child, provides health care to both infants and their mothers at that time.

Improving the quality and acceptability of services implies involving communities in planning, implementing and evaluating activities. Community participation makes services more responsive to local needs and promotes a sense of community "ownership"—the service is less likely to be perceived as being imposed by outsiders. This has been done in many ways, including the involvement of community councils (India), mothers' clubs (Republic of Korea), religious leaders (Indonesia), local volunteers (Philippines), schoolteachers (Thailand) and traditional healers (Mexico).

Improving the quality of services also means paying greater attention to the specific elements of programme management which are critical to the success—or failure—of health and family-planning programmes. Those elements include the selection and training of personnel, supervision, logistics, management information, client follow-up and evaluation, all of which become particularly important as services extend beyond clinics and major cities into remote rural areas and difficult-to-serve urban slums.

Many lessons have been learned from national programmes and operations research, yet in practice they are often ignored. Training, for example, should be practical rather than theoretical or abstract. Supervision should be consistent and involve more than routine checks on acceptor statistics. Supervisors should have a reliable means of transportation.

The past decades have also demonstrated the importance of offering clients a wide variety of safe and effective methods of contraception. Informed consumer choice, like contraceptive availability, is a key to family-planning success. In the 1960s and 1970s some programmes that promoted only one contraceptive method were damaged when negative rumours spread or the method proved unsatisfactory. Different contracep-

tives are appropriate for different clients, and even the same individual will have changing needs during her or his reproductive life. Thus, as wide a range of safe and effective contraceptives as possible should be made available to all segments of the population.

Serving the needs of high-risk groups

Young women

Although the extent of pregnancy among young women is not known with precision, it is believed to be quite widespread. "Young women" is susceptible to many definitions. Often it means women 20 years old or younger, who are termed "adolescents" in some societies. The health risks of pregnancy decrease as young women become older and reach biological maturity. According to data from the World Fertility Survey, in Bangladesh, Benin, the Dominican Republic, Ghana, Indonesia, Jamaica, Jordan, Kenya, Pakistan, Senegal, the Sudan and Yemen, over half of all women aged 25-29 had had their first birth before the age of 20.[15] In the Caribbean, almost 60 per cent of first babies are born to women under 19, and half of them are born to mothers under 17 years of age. In Indonesia, 41 per cent of the women have their first baby before they reach 17 years of age. In the United States, more than 1 million teen-age girls become pregnant every year, about 30,000 of them under 15.[16]

Most societies have ambivalent attitudes towards adolescent sexuality and adolescents, with the result that young people are often denied information and services. There is also a vocal religious and political opposition in many countries to providing public sex education and contraceptives to young people.

Despite all those complicating factors, a number of policy and programme options for influencing the timing of first births have been explored. They include raising the legal age at marriage, developing sensitive sex- and family-life-education programmes, providing family-planning and health information and services for young people (both married and unmarried) in settings appropriate for them, improving the educational and employment opportunities for young people, especially girls, and, in general, improving the economic and social status of women.

In societies where early marriage is common, raising the age at marriage, both legally and socially, encourages delayed childbearing, helps keep girls in school longer and influences future reproductive patterns. For example, if Bangladesh, where the mean age at first marriage is 16, were to adopt the Sri Lanka marriage pattern (average age at first marriage is 25), families would have an average of 2.2 fewer children.[17]

Raising the legal age at marriage, however, is only part of the answer. Marital patterns depend on cultural norms and customs and on social and economic conditions. Changing the law on age at marriage, on its own, has little influence on the cultural values that govern marital patterns unless it is accompanied by educational efforts and social/economic opportunities that provide alternative paths to childbearing at young ages.

Some cultural traditions, such as bride price, also encourage the custom of girls marrying at a very early age, and both economic and cultural conditions make it difficult to change those traditions. A major educational effort is needed to make communities understand the health risks involved

in very early pregnancy and childbirth and the lifelong impact that they have on the health and well-being of young women.

Educational efforts to delay the first pregnancy are more likely to influence the timing of first births outside marriage than the timing of the first birth within marriage. This is because the very cultural norms and values that encourage early marriage also require that fecundity, especially of women, be proved by a first child soon after marriage. Nevertheless, education on delaying the first birth may instil the concept of planning the timing of pregnancies, which can influence later reproductive behaviour.

Prevention of very early pregnancy, whether within or outside marriage, depends on adolescents having proper knowledge of such matters as the biology of human reproduction, human sexuality and contraception. The extent to which education on those topics is included in school curricula varies in different parts of the world. In many countries family-life education or science courses, in which sex education is taught, avoid issues of human sexuality and contraception.

Furthermore, even in those societies where sex education has long been established, there are fears, on the part of parents, that it will lead to early sexual activity and promiscuity. In some cases, these fears have been vocalized in requests for the elimination of sex education from school curricula or for exemption of their children from sex-education classes.

Lack of knowledge of human sexuality, including contraception and prevention of sexually transmitted diseases, breeds unnecessary suffering and misery among the young. That is particularly important given the world-wide threat of AIDS. Providing children with adequate education on those topics is a high priority for health education and family-planning programmes.

Even if family-life education is made more relevant and is better taught in schools, it will fail to reach the great majority of youth who do not continue their education past the primary grades. To remedy that, sex-education courses and information and counselling services to out-of-school youth have been established by private voluntary groups and religious organizations.

In addition to the sex-education courses and formal or less formal education programmes on human sexuality and reproduction, many adolescents need counselling in order to have a better understanding of those matters, to allay their anxieties and to reinforce the message of responsible sexual behaviour. Advice on contraceptive choices and how and where contraceptives can be obtained forms an important part of adolescent counselling. Several centres, such as The Door in New York City, the Adolescent Guidance Centre (CORA) in Mexico City, and The Way (El Camino) in Guatemala City, provide such counselling in the context of comprehensive programmes to help adolescents develop skills, find jobs and improve their health.

Family-planning programmes generally avoid serving unmarried adolescents. One survey noted that, as a matter of official policy, family-planning programmes in China, Indonesia, Malaysia, the Philippines and Taiwan Province distribute contraceptives only to married couples.[18] The same is probably true in many countries of Latin America, Africa and the Middle East.

Programmes that do serve unmarried minors face the significant issue of whether to inform the parents and seek their consent. A number of countries, including Great Britain, Thailand and the United States, make contraceptives available to both married and unmarried adolescents without the consent of their parents. Studies in the United States have shown that parental consent and notification requirements deter adolescents from seeking contraceptive advice and services.[19] Yet it is argued that omission of parental consent requirements undermines parental authority and encourages promiscuity.

The ideal situation is, of course, one where parents and authorities responsible for providing reproductive-health-care services to adolescents work together and where parents are a source of support to their children at a time of great anxiety. But that is not always the case. A solution adopted by some programmes is to encourage young people to involve their parents and, if that is not possible, to provide contraceptive counselling and services on a confidential basis.

Older and/or high-parity women

Pregnancy in older women of high parity carries increased health risks, especially in countries with high levels of poverty. Women in that age group often are ill-served by a primary-health-care system that ignores their needs and by family-planning programmes that emphasize certain methods rather than the reproductive health needs of the individual. Since such women often want to limit childbearing, they represent an audience which is, in many cases, already highly motivated.

In attempts to reduce the number of pregnancies among women over 35 or 40 who have many (more than four or five) children, policy-makers and programme managers have provided education on the dangers of further pregnancies to such women and services particularly appropriate for them. The services include injectable contraceptives which can offer protection for up to three or six months, implants such as NORPLANT, which offers protection for up to five years, intra-uterine devices and, most important, voluntary sterilization, which now protects more than 100 million individuals.

The services are not universally available because of political and religious opposition, uncertainty about their legality and accusations that some programmes have used coercive methods; and there remains a considerable unmet need for sterilization. A recent report estimated that in the developing world 40 per cent of the women and almost all of the men lack reasonable access to sterilization services.[20]

Birth spacing

A short interval (less than two years) between pregnancies presents a significant risk to the lives of children. The risk is highest when short intervals are combined with an early start to childbearing, but even with an optimum maternal age for the first birth, repeated short spacing can increase the risk of infant mortality by 60 to 70 per cent.

Birth spacing, through separation of husband and wife or periods of sexual abstinence—sometimes lengthy—after childbirth and through prolonged breast-feeding, is a traditional practice in many societies, especially in Africa. But such customs are becoming increasingly difficult to maintain in today's modern world, especially in view of the rapid flow of rural people into urban slums.

Strategies to promote better spacing of pregnancies have been developed and implemented in only a few programmes, and, in some, the contraceptives that are especially appropriate for spacing (oral contraceptives, spermicides and condoms, for example) may not be as easily available as those for limiting family size.

In recent years, a great deal of attention has focused on breast-feeding, which has the dual advantage of protecting the health of young children and delaying the return to fertility of new mothers. The relationship between lactation and post-partum amenorrhoea is well known; the longer and more extensively a mother breast-feeds, the longer she is protected against pregnancy, although the protection decreases over time.

A number of measures have been taken to encourage breast-feeding. To reverse the psychological mind set that breast-feeding is somehow old-fashioned or too much of a bother, radio, television, billboards and breast-feeding support groups (which exist in at least 25 developing countries) educate women about the benefits of breast-feeding.

Health-care professionals have been trained, and health-care services reoriented, to give support to mothers who nurse. Leading hospitals in Brazil, China, Honduras, India, Indonesia, Kenya, the Philippines and Thailand have changed to pro-breast-feeding policies. In Guatemala, changes in hospital routines to promote breast-feeding led to an increase in breast-feeding from 17 per cent to 54 per cent six months after delivery and from 0 to 29 per cent 12 months after.[21] Working women have been given more opportunities to breast-feed. Governments have encouraged partial breast-feeding—that is, nursing before going to work, upon returning home and before going to bed.

Finally, countries have enacted laws to restrict or prevent the public promotion of breast-milk substitutes in accordance with the International Code of Marketing Breast-Milk Substitutes, adopted by the World Health Assembly in 1981. Papua New Guinea is a much-cited example. In Port Moresby, the capital, prohibiting the advertising of breast-milk substitutes, coupled with a pro-breast-feeding publicity and education campaign, raised the prevalence of breast-feeding among children less than two years old from 65 per cent in 1976 to 88 per cent in 1979.[22]

Unwanted pregnancy and unsafe abortion

The World Fertility Survey and other studies have documented the extent of unwanted pregnancies throughout the world. They present a serious health hazard, because women are forced to choose between carrying to term a pregnancy that they do not want and seeking an abortion which in many cases will be illegal and unsafe. Prevention of unwanted pregnancy not only will protect women but also will lead to savings in health resources by reducing the costs of maternal care and abortion services and the treatment of incomplete or septic abortions.

The costs of unsafe abortions, in terms of human suffering, risk to health and drain on hospital budgets, are enormous. In some Latin American countries, 50 per cent of maternal deaths are due to illegal abortions, and half or more of the beds in maternity hospitals are used to treat abortion complications.[23] Recently published studies in Africa have indicated a high cost of abortion in cities on that continent.

Over the past two decades, there has been a trend towards easing restrictions on abortion throughout most of the developed world and in the non-Muslim countries of East and South Asia. In those countries, abortion is legal if the birth of a child would harm the pregnant woman's physical or mental health, if it would cause her extreme social or economic hardship or if she requests it early in pregnancy. In most of the rest of the world, induced abortion is illegal or permitted only to save the life of the woman.[24]

Communications strategies

Effective communications strategies play an important role in informing potential clients that services are available (and where to get them), dispelling negative rumours, activating latent demand and generating favourable attitudes towards responsible parenthood. Such strategies can also be used to generate support for family-planning policies and to neutralize political opposition, and, of course, they can inform people about other important threats to health, such as AIDS and other sexually transmitted diseases.

Person-to-person communication through field-workers, counsellors, satisfied clients and others remains the backbone of family-planning and health communications. Satisfied clients have proved to be effective communicators in programme after programme. They are also the best protection against unwarranted negative rumours about contraceptives.

Satisfied users have also been influential in blocking cut-backs in family planning. Their protests have been heard in a number of countries where "right-to-life" and other fundamentalist groups have tried to cripple family-planning programmes.

Certain channels of communication are particularly well-suited for reaching specific audiences. Radio, which is found in almost every village, is an important medium for communicating with potential clients. In contrast, television, limited largely to cities, is particularly appropriate for communicating with leadership groups. Films and newspapers can reach a substantial audience, although both have drawbacks: films need a secure power supply, often not available in rural areas, while newspapers require a literate readership and are distributed mainly in cities. Traditional theatre has been an innovative way of transmitting messages to rural areas in many countries.

Family planners, sometimes in collaboration with advertising agencies, have learned to make innovative use of the media, for example, through radio soap operas (Jamaica's *Naseberry Street* and Indonesia's *Grains of Sand*), rock videos (Mexico's *Cuando Estemos Juntos*), sex education through radio (Costa Rica's *Dialogue*) and creative point-of-purchase advertising (social marketing programmes in Bangladesh and Sri Lanka).

Successful communication campaigns appear to have a number of elements in common: they are based on carefully planned and comprehensive strategies; the target audience is clearly identified; messages are carefully pre-tested, often by using focus groups; evaluation is carried out and the findings are used to redesign strategies; and mass-media messages are linked with distribution networks.

Improved status of women and quality of life

Historically, family size has declined as standards of living have improved. Social and economic factors that have been associated with lower fertility include lower infant mortality, more education and higher and more equitable distribution of income.[25]

Improving the status of women is vital, both as a goal in itself and as a means of promoting better health. Education is probably the single most critical factor in furthering the psychological attitudes that lead to reduced mortality, morbidity and fertility.

A number of positive steps have been taken recently. Women's issues are now high on the agenda of most international conferences dealing with development, and many countries have appointed national commissions which have reported on and proposed steps to improve the status of women. The constitutions or laws of over 100 countries guarantee equality between men and women; strides have been taken to give women greater educational opportunities, particularly in East Asia and Latin America; and community-level programmes have attempted to empower women and strengthen their earning capacity.

Despite those efforts, women throughout most of the world do not enjoy the same levels of economic, social or political status as men. In many societies, women are still valued—both in their own eyes and in those of the male-dominated society—for their ability to bear children. A woman who cannot have children is often considered a pariah, and that attitude puts pressure on young girls to begin a large family early in life. Additionally, in many countries, a married woman has the legal status of a child or mentally retarded person, having rights only through her husband. A woman often cannot own land, inherit property or take out credit in her own name. Dowry, bride price and arranged marriages are common. The proportion of females in school—especially in secondary school—is less than males in most developing countries. In industrialized countries, where women's issues often focus on the workplace, females typically earn something like 60 per cent of the salaries of males.

This is not simply a "woman's problem"; it is one which, at its core, revolves around the attitudes of men. Males should be equal partners in decisions about childbearing, responsibility for family planning and women's roles and rights generally. In addition to encouraging use of male contraceptive methods such as condoms or vasectomy, programmes to involve males in responsible parenthood are springing up throughout the world. In countries as diverse as Jamaica, Mauritania, Mexico, Nigeria and Zimbabwe, men are offered discussion groups, lectures, drop-in centres, "fathers' clubs", counselling and more.

Availability and use of resources

At a time of acute debt crisis in many developing countries, fiscal austerity measures that affect budgets for health and other social-welfare programmes and uncertainties about the level of foreign aid, it is important to concentrate on cost-effective measures for providing health care. Family planning is one such cost-effective intervention.

If widely implemented, family planning could have a significant impact on national health and social-welfare budgets. A recent study of the Mexican Social Security Institute disclosed that for every peso invested in family planning, nine pesos were saved that otherwise would have been spent on maternal or infant health care.[26]

There are basically three sources of funding for family planning: public spending, private spending and foreign aid. Public-sector resources, which amounted to about $US 1 billion in 1980,[27] include governmental budgets (generally those of the ministry of health) plus those of parastatal organizations. Allocations to family planning in national budgets remain disturbingly low. Inadequate resources for family planning are compounded by equally inadequate health budgets, especially for primary health care. Family-planning services depend heavily on health infrastructures and manpower, which are inadequate, and sometimes non-existent, in many countries. And, as discussed above, the absence of effective health systems adversely affects family-planning efforts. Finding additional resources for family planning and using them more effectively than in the past pose major challenges to policy-makers, planners and programme managers.

The relatively small amounts spent on health and family planning are of particular concern because austerity measures are forcing cut-backs in public welfare programmes at the very time that the absolute numbers of poor people who need and want family-planning services are increasing dramatically.

Private-sector spending on family planning amounted to about $US 370 million in 1980, or about 20 per cent of the total expenditure worldwide. The regional variations are striking: 8 per cent in East Asia, 15 per cent in the Middle East, 25 per cent in South Asia, 38 per cent in sub-Saharan Africa and 53 per cent in Latin America.[28] Studies have demonstrated that people are willing to pay—and do in fact pay—for health services that are reliable and accessible.[29] In São Paulo, Brazil, for example, more than 90 per cent of the consumers of oral contraceptives and condoms received their supplies from pharmacies.[30]

Some service providers are now trying to recover at least some of the cost of services from clients without discouraging potential users or burdening those least able to pay—by charging for contraceptives, by selling family-planning services to businesses or Governments or by marketing ancillary services such as laboratory tests.

The proportion of total foreign aid directed to family planning is trivial—less than two thirds of 1 per cent of all official development aid. In dollar terms, that amounted to approximately $340 million a year in 1985. In constant dollar terms, foreign-aid contributions for family planning were static between 1982 and 1984 and showed a modest increase in 1985.[31]

Although institutional barriers to optimal utilization of health and family-planning resources exist and absorptive capacity is limited in some countries, the failure of foreign aid for family planning to rise substantially is disturbing. That is especially true in the light of the World Bank's assessment that by the year 2000 expenditures for family planning must increase by more than 50 per cent just to fulfil the unmet need for services, and foreign aid for family planning should triple in order to achieve a standard decline in fertility (total fertility rate of 3.3).[32]

IMPLICATIONS FOR HEALTH AND FAMILY-PLANNING POLICIES AND PROGRAMMES

The evidence demonstrates the need for policies and programmes to improve women's and children's health directly and to alleviate the social conditions responsible for poor health. That implies policies and programmes to improve the quality of people's lives, to upgrade the condition of women, and to provide health and, particularly, family-planning services.

The remarks below indicate the kinds of steps that would be required to integrate family planning fully into maternal and child health care. They are therefore explicitly prescriptive and reflect the views of the authors on what a programme planner or manager would need to do to improve maternal, infant and child health through family-planning and related health and development activities.

During the past decades, and especially over the past 10 years, many lessons have been learned from family-planning and health-care programmes. They point to a number of policy and programme actions that can be taken to improve health and family planning, especially in responding to the needs of those women most likely to suffer from complications of pregnancy and childbirth. The extent to which each of those actions will be effective will be determined by the social, cultural and economic conditions prevailing in individual countries and among different population groups.

Reorienting priorities

The principle that family planning is an integral part of maternal/child health and an essential component of primary health care has received wide acceptance but is not yet adequately reflected in field programmes. There is need to examine and, where necessary, revise policies and programmes on health and family planning to ensure that they take adequate account of the reproductive health needs of women and the health benefits of family planning to women and children. Primary-health-care and maternal-and-child-health programmes, in particular, need to be examined to ensure that family planning constitutes a key element in their design and implementation.

Maternal-and-child-health services have tended to focus on child health care, giving less attention to maternal health. That neglected component should be placed back on the agenda, accompanied by a strong educational effort to raise health consciousness among women, who often give low priority to their own health problems.

Family-planning policies and programmes need revision too, in order to ensure that women whose pregnancies carry special risks to their health or to the health of their children receive special attention. In particular, the importance of delaying childbearing until after adolescence and spacing pregnancies at least two years apart should be given greater emphasis.

Enacting policies and laws

Although most Governments have signed international agreements in support of family planning as a health-care service, policies, laws and regulations often discourage family planning and greater access to health services. Only physicians are authorized to provide health care in some countries; in others, the distribution of contraceptives is prohibited by law; while in others, a woman cannot receive family-planning services without her husband's consent.

Although laws are not always enforced and a delicate interaction exists between tradition, religious precepts and national laws, explicit laws and policies can have a positive effect by clearly defining the Government's position and setting a framework for programme action. Therefore, as an important first step, Governments should make it clear that they support family planning as a measure to protect the health of women and children and to enhance the condition of women.

Improving the accessibility, acceptability and quality of family planning

The expansion of services through community, commercial and other channels holds great promise for the future and gives a number of options to policy-makers and programme managers. They can train non-physicians, such as community health workers, teachers, shopkeepers and traditional birth attendants, to provide basic health and family-planning services—for example, immunization, oral rehydration therapy and delivery of contraceptives. Involving members of the community, especially women, in planning and carrying out health and family-planning programmes helps to increase their accessibility and acceptability. Another effective way of expanding health and family-planning services is by giving a greater role to the private sector—social marketing programmes, private physicians, commercial enterprises, health-care organizations and other providers of health services.

Research has shown that improvements in the quality of services can have a substantial impact on contraceptive prevalence and on health, through more effective and continuous use of services. Where health conditions are poor and where demand for family planning is low, improving service quality can be particularly crucial. Policy-makers and programme managers should make the perspective of the user the focal point in their efforts to raise the quality of service programmes. Other important elements of those efforts should include:

(*a*) a wide choice of methods, together with forthright information on the advantages and disadvantages of each method, in ways that are easily understood by potential users;

(*b*) improved competence of the providers, through clinical training and careful attention to better communication skills, including greater sensitivity to the client's perceptions and beliefs;

(*c*) improved client/provider relations through better selection, training and deployment of field-workers and continuous, supportive supervision;

(*d*) assurance of constant availability of services to encourage continued contraceptive use;

(*e*) an appropriate constellation of services that are both acceptable and convenient to clients, and are linked to primary-health-care and reproductive-health services.

Widespread availability of safer, more effective and more acceptable contraceptives remains a high priority for women's health and family-planning programmes. There is urgent need to increase public and private investment in contraceptive research and development in order to improve the safety and effectiveness of existing methods. Regulations governing contraceptive research and development should be reviewed in order to ensure that they do not unnecessarily hinder progress in those areas.

There is also need to build up local capacity to assess the contraceptive safety of individual methods under the conditions in which they are used. Efforts should also be made to encourage wider use of internationally accepted standards of contraceptive safety developed by such organizations as WHO and IPPF.

Post-marketing surveillance of newly introduced contraceptives and education of acceptors on proper use and on early recognition of side-effects will improve contraceptive safety. All those actions require that personnel be thoroughly knowledgeable about all aspects of contraceptive safety, including proper storage and handling of all contraceptives.

Along with the failure to take sufficient account of the client's perspective, the greatest barrier to programme effectiveness is probably lack of management capacity. Management improvement deserves highest-priority attention. Special attention needs to be given to the establishment or improvement of management information systems, efficient financial and supply management systems, monitoring and supervision systems and training and retraining programmes.

Improvements in those areas must be buttressed by solid programme evaluation and operations research to assess the effectiveness and costs of programmes.

Designing education and service programmes to serve the high-health-risk groups

A number of policy and programme measures can effectively reduce the health risks to women and children that are associated with childbearing patterns. Women for whom pregnancy and childbirth carry special health risks should be identified locally, taking into account the combined effects of maternal age, birth interval, parity and the prevailing social and economic conditions. Specific health care should be provided to women in those groups during pregnancy, childbirth and the post-partum period, and to their children during the first few years of their lives.

Delaying first births

For health, social and educational reasons, encouraging postponement of first pregnancies until at least late adolescence should be a high priority. Although in some countries strong cultural and societal pressures encourage early childbearing, a number of policy measures may help lessen their impact.

The legal age at marriage has been raised in a number of countries in order to discourage early parenthood. That legal approach is most effective when the law is enforced and educational efforts made to increase public understanding of the lifelong impact of early childbearing and of the risks it carries to both mothers and children. Providing young people, especially girls, with education, employment and other life-enhancing opportunities that are a realistic alternative to early parenthood is also crucial.

Sex-education and family-life-education programmes need to reach both in-school and out-of-school youth. The programmes should include instruction on human sexuality, responsible parenthood, contraceptive choices and where advice, services and supplies can be obtained. A range of pre-natal, maternity, post-natal and other relevant care and counselling should be offered to young women who become pregnant.

Reducing births among older and high-parity women

There is need to make a special effort to serve the reproductive health needs of older and/or high-parity women. Contraceptive methods that are particularly suitable for those women should be widely available. Among them, voluntary sterilization has a special place. Laws should be reviewed to make sure that the procedure is legal. Its acceptance must be based on voluntary, informed consent.

Spacing births at least two years apart

Despite the health risks of spacing births too closely and the widespread desire for having pregnancies farther apart, spacing has not received the attention it deserves in family-planning programmes. Education on spacing should be included in antenatal and post-natal care and in post-partum education.

Family-planning programme managers must ensure widespread availability of contraceptives suitable for spacing purposes, including those appropriate for lactating women. There is also need for an educational effort to make contraception an acceptable alternative to eroding traditional birth-spacing practices and to encourage breast-feeding through a number of steps, including national enforcement of the International Code of Marketing Breast-Milk Substitutes; developing educational campaigns to promote breast-feeding; training health-care professionals in the importance of lactation problems; reorienting health-care services to give support to mothers who nurse; and giving working women more opportunities to breast-feed.

Reducing unwanted pregnancies

Unwanted pregnancy, regardless of maternal age and parity, is a major risk to the mental and physical health of women, especially because it may result in illegal abortion. Prevention of unwanted pregnancy will not only protect women but also lead to savings in health resources by reducing the costs of maternal care and abortion services and the treatment of incomplete abortions.

There is need to alleviate the problem of unsafe and incomplete abortion. Essentially, there are three policy and programme options, which are not mutually exclusive: legalizing abortion and making quality services available; improving health services for those who need care after incomplete abortions; and promoting contraception as an alternative to abortion.

Where abortion is legal, health professionals and other concerned individuals should ensure that the law is implemented and that women have access to high-quality and affordable abortion services without unnecessary restrictions.

Where abortion is not legally available, emotional suffering and damage to health caused by illegal abortion should be documented and publicized. In all cases, services and care should be provided for the treatment of incomplete abortions and contraceptive advice, and services should be provided to reduce the number of abortions.

Educating and informing individuals

It is essential to ensure that communication strategies are comprehensive, well-conceived and meaningful to specific target audiences—for example, policy-makers or potential acceptors. Such strategies are often more effective when planned and implemented in conjunction with the provision of services.

More focused attention on those for whom pregnancy and childbirth constitute a health risk requires special strategies for reaching different risk groups. They should be given clear information on the risks involved, how they can be avoided, and where services can be obtained.

Men should be a particularly important target group, in part because of their influence on contraceptive decisions in many countries, in part because of the need to increase the understanding among them of responsible parenting and in part because of the growing threat of AIDS.

Another high priority in communication activities is building up public and political support, especially as an effective way of dealing with potential or existing opposition. Special efforts should be made to enlist the support of parliamentarians, the legal community and other influential groups.

Personal communication is still the crucial element in informing and educating people. Satisfied users, in particular, are able to counteract negative rumours about the effects of contraceptives and, if mobilized, to form an effective pressure group to promote family planning.

The mass media offer an important way of raising public consciousness of reproductive health and family planning. Each medium may be particularly appropriate for certain audiences. The electronic media, partic-

ularly, offer the opportunity for creative education and communications activities, always bearing in mind that the perspective of the listener or viewer is key.

Increasing financial resources and improving their use

With increasing demand for family-planning services and the recognition of their importance as a health measure, both national budgets and international aid for family planning need to be increased substantially. A tripling of foreign aid by the year 2000, as proposed by the World Bank, should be accepted as a global target.

Efforts to increase funding for family planning at national and international levels need to be supported by resource development, both financial and human, at the local level. That can be achieved by increasing the participation of the private sector, strengthening the financial capacity and the role of non-governmental organizations and developing mechanisms for recovering some of the costs of providing services from consumers who can afford to pay.

Experience in the past decade has also shown the need for ensuring efficient use of financial and other resources. Establishing better financial management practices requires particular attention. There is also need to review donor policies and practices and to revise those that may act as impediments to the rapid transfer and efficient use of funds.

Improving the quality of life and the condition of women

Good health is a goal in itself, as is general well-being. All Governments have policies that attempt to improve the welfare of their people. It is a historical phenomenon that, as the quality of individuals' lives improves, the number of children that they want decreases. Therefore, high priority should be given to bringing about the conditions that raise the quality of life and, thus, reduce the demand for large families. At a minimum, that includes a proper amount of food to eat and adequate education, housing, income and health care.

Perhaps the single most critical element is improving the condition of women. The Convention on the Elimination of All Forms of Discrimination against Women provides a comprehensive guide to making women equal partners in development. It is important that those Governments that have not ratified the Convention be urged to do so and those that have ratified it be urged to implement its principles vigorously. Laws and policies affecting women should be examined with a view to removing any legal or policy obstacles to women's development.

Highest priority should be given to raising the educational level of women by encouraging parents to keep their daughters in school and by providing education for women outside of classrooms and through other means.

Other key policy and programme steps that should be taken to improve the condition of women include establishing programmes at all levels to enable women to plan and control their own lives and to earn a decent income; recognizing women's rights, particularly reproductive

rights, as just as important as any other human rights; and strengthening women's organizations and encouraging their policy and programme roles.

NOTES

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[4] S. Halstead, J. Walsh and K. Warren, eds., *Good Health at Low Cost* (New York, Rockefeller Foundation, 1985); J. Caldwell, "Routes to low mortality in poor countries", *Population and Development Review*, vol. 12 (1986), p. 171.

[5] N. Heckel, "Population laws and policies in sub-Saharan Africa: 1975-1985", *International Family Planning Perspectives*, vol. 12 (1986), p. 122.

[6] See R. Simmons and J. Phillips, "The integration of family planning with health", in *Organizing for Effective Family Planning Programmes*, R. Lapham and G. Simmons, eds. (Washington, D.C., National Academy of Sciences, 1987); and H. Mosley, book review of *Child and Maternal Health Services in Rural India: The Narangwal Experiment* in *Population and Development Review*, vol. 11, No. 3 (1985), p. 529. Both articles contain comprehensive reviews of field experiments carried out in a number of countries. See also L. Chen, "Primary health care in developing countries: overcoming operational, technical, and social barriers", *Lancet* (29 Nov. 1986), p. 1,260.

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[9] World Bank, *World Development Report, 1984* (Washington, D.C., 1984), pp. 149-151.

[10] See M. Ainsworth, "Family planning programmes: the clients' perspective", World Bank Staff Working Paper No. 676 (1985).

[11] J.-P. Habicht and P. Berman, "Planning primary health services from a body count", *Social Science and Medicine*, vol. 14C (1980), p. 129.

[12] H. Lipton, R. Dixon-Mueller and P. Lee, "Client provider transactions: an introduction and conceptual overview", and the succeeding five articles in *Organizing for Effective Family Planning Programmes*, R. Lapham and G. Simmons, eds. (Washington, D.C., National Academy of Sciences, 1987); and G. Zeidenstein, "The user perspective: an evolutionary step in contraceptive service programmes", *Studies in Family Planning*, vol. 11, No. 1 (1980), p. 24.

[13] S. Schuler and M. Goldstein, "Family planning in Nepal from the user's and nonuser's perspective", *Studies in Family Planning*, vol. 17, No. 66 (1986). See also R. Simmons, M. Koblinsky and F. Phillips, "Client relations in South Asia: programmatic and societal determinants", *Studies in Family Planning*, vol. 17, No. 6/Part I (1986), p. 257.

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[17] World Bank, *World Development Report, 1984* (Washington, D.C., 1984).

[18] J. Paxman and J. Zuckerman, *Laws and Policies Affecting Adolescent Health* (Geneva, WHO, 1987).

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[22] Edward Baer, "Promoting breast-feeding: a national responsibility", in *Studies in Family Planning*, vol. 12, No. 4 (1981), Edward Baer and B. Winikoff, eds., p. 202.

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[24] C. Tietze and S. Henshaw, *Induced Abortion: A World Review* (New York, Alan Guttmacher Institute, 1986).

[25] World Bank, *World Development Report, 1984* (Washington, D.C., 1984). The importance of women's education in lowering mortality and fertility has been emphasized by H. Mosley, "Will primary health care reduce infant and child mortality?" in *Health Policy, Social Policy, and Mortality Prospects*, J. Vallin and A. Lopez, eds. (Liège, Ordina, 1985), and J. Caldwell, "Routes to low mortality in poor countries", *Population and Development Review*, vol. 12 (1986), p. 171.

[26] D. Nortman, J. Halvas and A. Rabago, "A cost-benefit analysis of the Mexican Social Security Administration's family planning programme", *Studies in Family Planning*, vol. 17, No. 1 (1986), p. 1.

[27] It is difficult to get an accurate picture of the amount of money allocated to family planning for a number of reasons: family planning is often not separated from other health expenditures, particularly when in integrated programmes; budget authorizations are not necessarily the same as expenditures; sometimes allocations to family planning are lumped under population assistance; varying exchange rates make translation into United States dollars difficult; accurate records of private-sector sources are not easy to obtain. The three primary sources used in this section are the World Bank, *World Development Report, 1984* (Washington, D.C., 1985); R. Bulatao, "Expenditures on population programmes in developing countries: current levels and future requirements", World Bank Staff Working Paper No. 679 (Washington, D.C., 1985); and personal communications with D. Nortman, based on her analysis of data of the United Nations Population Fund. All three sources provide information based on population programmes. The *World Development Report, 1984* estimated that two thirds of the money directed to population assistance was used for family-planning purposes, and the authors have used that estimate in making their calculations.

[28] R. Bulatao, "Expenditures on population programmes in developing countries: current levels and future requirements", World Bank Staff Working Paper No. 679 (Washington, D.C., 1985).

[29] WHO, *Economic Support for National Health for All Strategies, Background Document* (Geneva, 1987). See also D. de Ferranti, "Strategies for paying for health services in developing countries", *World Health Statistics Quarterly*, vol. 37 (1984), p. 428.

[30] *Population Today*, vol. 15, No. 3 (1987), p. 8.

[31] D. Nortman calculated that in 1985 unduplicated population assistance from developed to developing countries amounted to $US 510 million. If two thirds was directed to family planning, the amount would be $342 million. According to Nortman, and using the same two-thirds figure, population assistance to family planning was $272 million in 1982, $277 million in 1983, $297 million in 1984 and $342 million in 1985.

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AGE AT FIRST MARRIAGE AND AGE AT FIRST BIRTH

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SUMMARY

This paper presents findings on patterns of age of first marriage and age of first birth for 41 countries participating in the World Fertility Survey programme. The age distribution of first marriage and first birth is summarized with three statistics: the mean, the standard deviation and the proportion ever experiencing the event. The particular method of estimation is based on a model that ensures that estimates for all cohorts are comparable, even though some women have completed their reproductive experience while others have not. The analysis provides insights into sources of error in the reporting of age at first birth. In addition, trends and cross-country patterns are documented and conclusions are drawn about the adequacy of those statistics for the description of patterns of age at first birth and age at first marriage.

INTRODUCTION

In this report we present estimates at the national level for 41 countries of age at first birth and age at first marriage, based on data from the World Fertility Survey. In each country, for each of six standard five-year age cohorts (20-24 through 45-49), we summarize the age distributions of first marriage and first birth with three statistics: the mean (a measure of the central tendency), the standard deviation (a measure of spread) and the proportion ever experiencing the event. Using those estimates, we examine variation across both countries and cohorts. Examination of the former yields conclusions concerning the international variability in that aspect of the reproductive process, while examination of the latter provides estimates of secular trends. We concentrate on graphical analysis in the main body of the report, with detailed country tables confined to annexes. The particular method of estimation we employ (described below) is based on a model which ensures that estimates for all cohorts are comparable, even though some have completed their experience (e.g., the cohort 45-49) while the experience of others (e.g., the cohort 20-24) is quite incomplete. For young cohorts, the estimates we present are therefore predictions of what the summary statistics will be once the cohort has reached age 50.

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Age at marriage and age at first birth are two related—though distinct—measures of the start of a woman's reproductive life. To a first approximation, entry into marriage signals the beginning of exposure to the risk of becoming pregnant. The WFS recognized the importance of the event by using a wide definition of marriage that encompassed all types of reproductive unions, including consensual or common-law unions and visiting unions (in the Caribbean and a few African countries). Even a broad definition, however, does not encompass every sexual encounter, and therefore our results do not pertain to age at first intercourse but rather to age at entry into a socially recognized sexual union. In those Asian and Middle Eastern countries in which marriage may occur some time before the formal consummation of the union, some care was taken to obtain the age at which the partners actually began cohabiting and consummated the union, which is treated by WFS as the relevant age at entry into a union. For convenience, we will use the term "marriage" throughout the report, but the reader must remember that it is shorthand for a socially recognized sexual union.

The age at which women marry has important demographic, social and economic implications. Other things being equal, an earlier age at marriage implies an earlier initiation of childbearing, which in turn implies either a higher level of lifetime fertility or a longer period of exposure to the risk of unwanted childbearing once the desired family size has been attained. In every society, entry into marriage signifies a considerable change in the role and status of the woman, and in some societies, an early age at marriage inhibits further educational attainment or employment.

The age at which women initiate childbearing influences a variety of demographic and non-demographic phenomena. In the absence of active fertility control, the total number of births women bear through the reproductive period is largely a function of the age at which childbearing begins. In settings in which fertility control is exercised, most ages at first birth are compatible with a wide range of completed fertility levels, with the range severely constricted only for those women who begin childbearing quite late. In such settings, the age at first birth is none the less of interest because of its effect on the timing of childbearing within the reproductive period. With the average completed family size held constant, younger childbearing implies higher aggregate rates of fertility and of population growth (Coale and Tye, 1961). In addition, as stated earlier, younger ages at first birth are typically associated with younger ages at the achievement of desired family size, and, as a consequence, a longer period of exposure to unwanted births if fertility control is imperfect.

Furthermore, there is evidence that the timing of childbearing has an impact on variables other than fertility itself. Infant and child mortality tend to be higher among children born to women under age 20 and over age 35 (Rutstein, 1983; Trussell and Pebley, 1984). Hobcraft (1987) found strong effects on child survival in studying 34 of the 41 countries in this report. Compared to second- or third-order births to women aged 25-34, births to women under age 20 experienced an increased risk of death before age five of about one third. Likewise, maternal morbidity is greater among very young or old mothers (Nortman, 1974). More generally, due to the usual incompatibility of childbearing with school attendance and, in many societies, with wage-earning employment outside the home, the tim-

ing of childbearing can influence the educational and employment experiences of young women.

Information from developing countries on the socio-economic consequences of the timing of first birth is rather limited. Newman (1978) indicates that in India, an early first birth is essential to secure a woman's place in her husband's family. There is also evidence that Latin American women have a strong incentive to begin childbearing, since the arrival of the first child results in their acceptance and recognition as an adult, and little disincentive, since their life opportunities do not seem to be restricted by early childbearing. Several studies indicate, nevertheless, that in Latin America, particularly in urban areas, early childbearing is associated with lower educational attainment, although the direction of association is not clear (Engle, 1978; Law, 1978; Scrimshaw, 1978; Pebley, 1981). Early childbearing may also be associated with more rapidly paced subsequent fertility, as found in Costa Rica and, to a lesser extent, in Guatemala (Pebley, 1981). Those limited results suggest that in some developing countries (at least in those where women have opportunities for education and employment), an early first birth may limit women's future life options. Darabi and her colleagues (1979) argue, however, that even if the age at first birth does not directly affect the future life course of women in developing countries, the frequency of early first births in those countries should generate concern, both because of increased health risks to women and children and because of the relation between early first births and large family size, which results in economic hardship for many families. Hobcraft (1987) found that an early first birth greatly reduces the chances of survival of that child. First births experience excess mortality of about one third as compared to second- or third-order births to women aged 25-34. And first births to women in their teen years experience excess risk of dying before age 5 of 80 per cent.

Evidence from the United States suggests that women who have early first births experience more closely spaced subsequent births, face greater marital instability, are more poorly educated and have fewer assets and lower incomes later in life (Bumpass, Rindfuss and Janosik, 1978; Card and Wise, 1978; Coombs and Freedman, 1970; McCarthy and Menken, 1979; Rindfuss, Bumpass and St. John, 1980; Trussell and Abowd, 1982; Trussell and Menken, 1978). Given those adverse consequences, one would expect that the children of teen-age parents would also be relatively disadvantaged. Indeed, Card (1981) found that such children were more likely to have lower academic achievement and to show a tendency to repeat the early-marriage, early-childbearing and high-fertility cycle of their parents, even when other background variables are controlled. The situation may be quite different, however, in more traditional societies in which childbearing in adolescence is seen as a normal part, rather than an interruption, of the life course.

The strength of the relation between age at first birth and age at first marriage will obviously vary across populations. In those societies in which marriage occurs considerably later (say, at least two years) than menarche and also signals the beginning of sexual relations, marriage will be followed closely (on average by about 15 months) by a birth if contraception is not practiced. Even if couples contracept, the relation should still be positive and strong because only a minority of those who will ever

use contraception will do so to delay the first birth. In yet other societies, the marriage ceremony may take place substantially before cohabitation begins. Because WFS was careful in those instances to code the date of marriage as the date at which cohabitation began, a strong positive association between age at marriage and age at first birth will be evident. Nevertheless, despite the strong empirical relation between the two variables, entrance into marriage and entrance into childbearing signify distinct—albeit related—changes in status and role, and for that reason investigation of each one separately is of interest.

With the estimates presented here, further analysis could elucidate the relationship of the changes in marriage and first birth with other demographic, social and economic changes. Our report is intended to supplement earlier WFS publications based on findings for a much smaller number of countries. The reader is particularly directed to the studies by Casterline and Trussell (1980) on age at first birth and by Smith (1980a) on age at first marriage.

Data

Interviews in the World Fertility Survey took place in two stages. A household interview collected basic information on all members in the household, including age and marital status. More intensive reproductive histories were provided by a selected subsample of women of reproductive age. Because information about all members of the household could be provided by one individual (and not necessarily a female member) in the household survey, it is to be expected that better-quality data on age and marital status of women would be collected in the individual intensive survey, since each respondent provided information about herself. Subsequent evaluations of quality of data confirm that expectation (Goldman, Rutstein and Singh, 1985).

Data on age at first marriage and age at first birth were collected only in the intensive individual survey. In 20 of the 41 surveys collected in developing countries, the intensive interview was administered to women regardless of marital status; in the remaining 21 countries, only ever-married women were eligible for the intensive survey (see table 1). Using techniques described below, we are able to estimate in a straightforward manner from all-women samples the mean and standard deviation of age at marriage and age at first birth as well as the proportions of women who will ever experience those events. We can also combine information on the proportions married from the household survey to recover the same statistics on marriage for the remaining countries. To estimate the parameters of the distribution of age at first birth is more problematic for the samples restricted to ever-married women, since we need information on the population of never-married women who experienced a birth. Having no other alternative if we wish our estimates to pertain to the entire population, we must assume that never-married women have not experienced births. Note that we do *not* assume that there are no premarital births, only that unmarried women who have a birth subsequently marry (before the survey).

Detailed evaluations of data quality have been conducted for many WFS surveys (United Nations, 1987 and Goldman, Rutstein and Singh,

TABLE 1. COUNTRIES INCLUDED IN THE ANALYSIS, BY ELIGIBILITY CRITERION, FOR THE INTENSIVE (INDIVIDUAL) SURVEY

All women	*Ever-married women*
Benin (1981/82)	Bangladesh (1975/76)
Cameroon (1978)	Egypt (1980)
Colombia (1976)	Fiji (1974)
Costa Rica (1976)	Indonesia (1976)
Dominican Republic (1975)	Jordan (1976)
Ecuador (1979)	Lesotho (1977)
Ghana (1979/80)	Mauritania (1980/81)
Guyana (1975)	Malaysia (1974)
Haiti (1977)	Nepal (1976)
Ivory Coast (1980/81)	Pakistan (1975)
Jamaica (1975/76)	Peru (1977/78)
Kenya (1977/80)	Philippines (1978)
Morocco (1980)	Portugal (1979/80)
Mexico (1976/77)	Republic of Korea (1974)
Nigeria	Sri Lanka (1975)
Panama (1975/76)	Sudan (1978/79)
Paraguay (1979)	Syrian Arab Republic (1978)
Senegal (1978)	Thailand (1975)
Trinidad and Tobago (1977)	Tunisia (1978)
Venezuela (1977)	Turkey (1978)
	Yemen (1979)

NOTE: Date in parentheses indicates the year of the survey.

1985 (summarized in Singh, 1987)). As stated earlier, one common finding is that the quality of data in the household survey falls short of that in the individual survey. Hence, for those 41 countries in which we must mix data from the two sources to obtain estimates, we might expect less reliable results. On the other hand, comparison of WFS surveys with external sources reveals that WFS has usually been more successful than previous surveys in obtaining accurate fertility and marriage data. As would be expected, the data for older women are generally less reliable, since such women are asked to provide information on events (marriage and birth) in the distant past. Similarly, there is variation across countries, with surveys in the Asia and Pacific region generally providing data of high quality, those in sub-Saharan Africa and the Caribbean providing data of lower quality and those in Latin America and in Arabic-speaking countries providing data of intermediate quality. In addition, in Latin America the marriage data are often less reliable than the birth-history data, probably because the event of marriage and the state of marriage are less clearly defined (United Nations, 1987).

METHODS

The cross-sectional nature of the surveys conducted by the WFS makes comparisons of age at first birth or age at first marriage difficult for different cohorts, since the experience of younger women is decidedly less

complete than that of their older sisters. In the WFS first-country reports, cohorts were made comparable by the artificial device of truncating observation at age 25 and calculating the mean age at marriage of those who married before age 25 for cohorts aged 25 and over. But no one is really interested in the mean age at marriage of those who married before age 25 because such a conditional mean may conceal more than it reveals. Cross-country comparisons are particularly difficult to interpret if the conditional mean is the summary statistic, because the fractions of women who marry by age 25 among those who will ever marry vary widely across populations.

Another analysis strategy has been to summarize the marriage or first-birth distribution with a single summary statistic—the median age at the time of the event. Since more than 50 per cent of women have experienced a birth or marriage by age 25 in the majority of WFS countries, such a comparison across cohorts is indeed enlightening. However, that approach gives no indication of either the spread of the distribution or the proportion ever experiencing the event. A variant of the approach is to report not only the median but also the entire cumulative distribution function, at least in so far as it can be calculated. From the empirical distribution function, measures of the spread, such as the interquartile range, are available. Nevertheless, fewer than 75 per cent of women will have experienced marriage or first birth in many of the younger cohorts, so that that measure of dispersion is not calculable and, in any event, the proportion ever experiencing the event cannot be computed.

A third approach—the one we adopt here—is to fit a model schedule to the data. One uses the data available (for example, ages at marriage up to age 25 for women aged 25 at the time of the survey) to estimate the parameters of the model. Once the parameters have been estimated, the analyst can predict the remaining future experience of the cohort if he assumes that the model will continue to hold. Clearly, the higher the fraction of the experience of the cohort already observed and available for estimating the parameters of the model, the better the predictions. For that reason, we present results in this section only for cohorts above age 20. The estimates for the cohorts aged 20-24 should nevertheless often be viewed with caution, particularly when the estimated mean exceeds 24.

The particular model we employ was developed by Coale as a model of first marriage. The Coale/McNeil marriage model is based on the observation by Coale (1971) that a common structure underlies age distributions of first marriages in different populations. As shown by Coale and further supported by numerous other studies inspired by Coale's work, that distribution is smooth, unimodal, skewed to the right, and close to 0 below age 15 and above age 50. Furthermore, Coale observed that the differences in age-at-marriage distributions across female populations are almost entirely accounted for by differences in their means, their standard deviations and their cumulative values at the older ages—e.g., age 50. To facilitate the application of that finding, Coale constructed a standard schedule of age at first marriage using data for Sweden, 1865-1869. In later work, Coale and McNeil (1972) developed a closed-form expression that closely replicated the Swedish standard (and many other observed marriage distributions, after suitably transforming their means, standard deviations and cumulative values at age 50). The mathematics leading to that expression

also provided an appealing behavioural interpretation of the social process underlying entry into first marriage. According to that interpretation, age at marriage is viewed as the sum of a series of random variables, the first describing the age at which a woman first becomes marriageable (assumed to be normally distributed) and the others measuring the successive delays between becoming marriageable and meeting one's first spouse, meeting one's first spouse and becoming engaged and becoming engaged and getting married (with those random variables all assumed to be exponentially distributed with parameters in arithmetic sequence).

As reformulated by Rodriguez and Trussell (1980), the model has three parameters: the mean (μ) and the standard deviation (σ) of age at marriage among those who ever marry, and the proportion who ever marry (PEM). In formal terms, the Coale/McNeil model can be expressed as:

$$g(a) = \frac{\text{PEM}}{\sigma} 1.2813$$

$$\exp\left[-1.145\left(\frac{a-\mu}{\sigma} + .805\right)\right.$$

$$\left. - \exp\left\{-1.896\left[\frac{a-\mu}{\sigma} + .805\right]\right\}\right] \qquad (1)$$

where $g(a)$ is the proportion of women marrying at age a in the observed population and μ, σ and PEM are, respectively, the mean and standard deviation of age at marriage (for those who ever marry) and the proportion of women ever marrying. Rodriguez and Trussell (1980) have derived the likelihood function associated with the model and have developed the computer program NUPTIAL (available from the International Statistical Institute in The Hague) to estimate its parameters from survey data drawn either from a sample of all women or from a sample of women who married prior to the survey date. In the latter case, only the parameters μ and σ are estimated, unless (as in the case here) information on the proportion ever married by age is available from a household survey. Several illustrative analyses have already been published (see Trussell, 1980; Smith, Shahidullah and Alcantara, 1983).

Subsequent research has done little to either confirm or deny the behavioural interpretation of the Coale/McNeil model. However, the interpretation does suggest that the marriage model can also be applied to distributions of age at first birth. That conclusion hinges essentially on the assumption of an exponential delay between first marriage and first birth, which would be true if there were no childbearing outside of marriage, if all women were equally fecund and if fecundability did not decline with age. That conclusion follows because the convolution of a normal and *four* exponential delays can be very closely approximated by the convolution of a normal and *three* exponential delays (Coale and McNeil, 1972). Regardless of whether any of the behavioural assumptions underlying the Coale/McNeil model are valid, recent empirical studies have confirmed its ability to replicate first-birth distributions and have demonstrated its usefulness in their analysis (Bloom, 1982a, 1982b; Casterline and Trussell, 1980; Hob-

craft and Trussell, 1980; Rodriguez and Trussell, 1980; Trussell, Coale and Menken, 1982; Trussell, 1980; Bloom and Trussell, 1984; Trussell and Bloom, 1983; Pebley, Casterline and Trussell, 1981).

We hasten to note that the investigators cited above have found that the model, when measured by conventional "fit" tests, often does not fit WFS data well. In particularly, p values (which can be roughly interpreted as the probability that the model fits) are often substantially less than 1 and sometimes near 0. To a large extent, the lack of fit is caused by irregularities in the data (age heaping, digit preference) that no model could ever hope to replicate, at least not without becoming much more complex and difficult to estimate; moreover, we question the wisdom of even attempting to capture such irregularities. Since we are using the model to summarize the basic structure in the data, we are not much concerned with lack of fit, particularly when different age groups within a cohort do not share a common pattern. We nevertheless invite the readers to judge for themselves; p values for the overall fit and for homogeneity of cohorts are given in the detailed tables in the annexes.

One final methodological note is in order. Occasionally, the estimated value of the proportion ever marrying or the proportion ever having a birth exceeded 1.0, sometimes by substantial amounts. Where the value exceeded 1.01, we fixed the parameter at a level consistent with the values for other cohorts in the same population and re-estimated the other two parameters (μ and σ). The original values are given in annexes III and IV. Examination of the estimated proportions ever experiencing the event (marriage or birth) also revealed that occasionally the values for the youngest cohorts were implausibly low. In that circumstance, we accepted the implausible values, but we do show the results of fixing the proportion at a more reasonable value in annexes III and IV. In the Coale/McNeil model, if one raises the value of the proportion ever experiencing the event, the mean (and the standard deviation) always rises. Hence, in those cases in which the estimated proportion seems too low, raising it to a more plausible level also raises the mean. Therefore, in those cases (see annex I), if the model is a reasonable description of reality, one must choose between a very high mean for a few of the youngest cohorts or a very low proportion ever experiencing the event.

Age at marriage and proportions ever marrying

Figure I displays the time trends in the estimated mean age at marriage for all 41 countries. The 41 surveys were conducted over a period of eight years, 1974-1981, and encompass countries that are at different points in their historic process of fertility change. Only a few countries are labelled, because our emphasis here is on commonalities and differences across countries. The reader is referred to annex I for full details for all countries.

Two countries immediately stand out in figure I. In Bangladesh, the mean age at marriage is below 14 years for all cohorts. At the other extreme lies Portugal, where the mean age at marriage has hardly deviated from 24 years for all cohorts. The very young ages at marriage for all cohorts in Bangladesh force us to question whether WFS was successful in

obtaining accurate responses. To mitigate the possibility of any ambiguity, respondents were asked to report both their age at formal marriage and their age when they actually "joined with" their husbands. WFS treated the later age as the relevant age at marriage. The term "joined with" was intended to refer to age at consummation, but it could also have been interpreted by the respondent as the age at which she moved into her husband's household. Indeed, the mean reported age at "joining" is less than the mean age (about 15.7) at menarche (Chowdhury and others, 1977; Foster and others, 1984), so the validity of the responses is uncertain.

Two features revealed by figure I are that age at marriage was quite variable across countries for the oldest cohorts and that the spread is even greater among the younger cohorts (see figure I-B).[1] A third noticeable aspect is that only a few countries have marked time trends. In only 12 countries is there a change in mean age at marriage of more than two years from the oldest to the youngest cohorts; those are displayed separately in figure I-A so that they can be individually identified. In two of them, mean age at marriage has declined across time. In Jamaica the trend is due solely to changes in the oldest three cohorts, and in Cameroon it is due solely to a high estimated mean for the oldest cohort; we suspect that the magnitude of the trend is only apparent, due to defects in the data, and not real. In 10 of the populations there is a marked trend towards later age at marriage (Egypt, Fiji, Indonesia, Jordan, Malaysia, Morocco, Peru, Republic of Korea, Sri Lanka and Tunisia). In six of the 10, the trend is either monotonic or nearly so, and there is little doubt that the upward trend is real (Fiji, Jordan, Malaysia, Morocco, Republic of Korea and Sri Lanka). The most spectacular increases occur in Malaysia (from 17.8 at 45-49 to 23.1 at 20-24), Republic of Korea (from 17.6 to 23.7), Sri Lanka (from 19.8 to 24.8) and Morocco (from 16.3 to 20.6). In Indonesia, Peru and Tunisia, an increase is apparent only among the youngest two or three cohorts.

The estimated time trends in the standard deviation of age at marriage are shown in figure II. The range is from about three (all cohorts in Bangladesh) to over six, with the preponderance of estimates falling between four and six. Nine countries (Egypt, Indonesia, Malaysia, Morocco, Peru, Republic of Korea, Sri Lanka, Thailand and Venezuela) display a tendency for age at marriage to become more heterogeneous over time, and the increase in the standard deviation of age at marriage from the oldest to the youngest cohort exceeds 1.0 years in all but three of them (Egypt, Thailand and Venezuela). Those countries are shown separately in figure II-A. As was true of the rise in the mean age at marriage, the increase in the spread is most pronounced in the Republic of Korea (2.5 to 4.3), Malaysia (4.9 to 6.5), Morocco (3.7 to 5.9) and Sri Lanka (5.7 to 8.0).

Finally, we show the estimated trends in proportions ever marrying in figure III. It is evident that in the majority of countries (21), the proportion ever marrying is .95 or higher in every cohort. In an additional six countries, only in the youngest cohort is the proportion ever marrying expected to be below .95. In contrast, only in three populations (Colombia, Costa Rica and Ecuador) does the proportion ever marrying never exceed .95 for any cohort. Countries with especially marked time trends are displayed in figure III-A. There is a general trend towards a decrease in proportions ever marrying, with monotonic trends over all cohorts in 11 countries

Figure I. Mean age at first marriage, by cohort

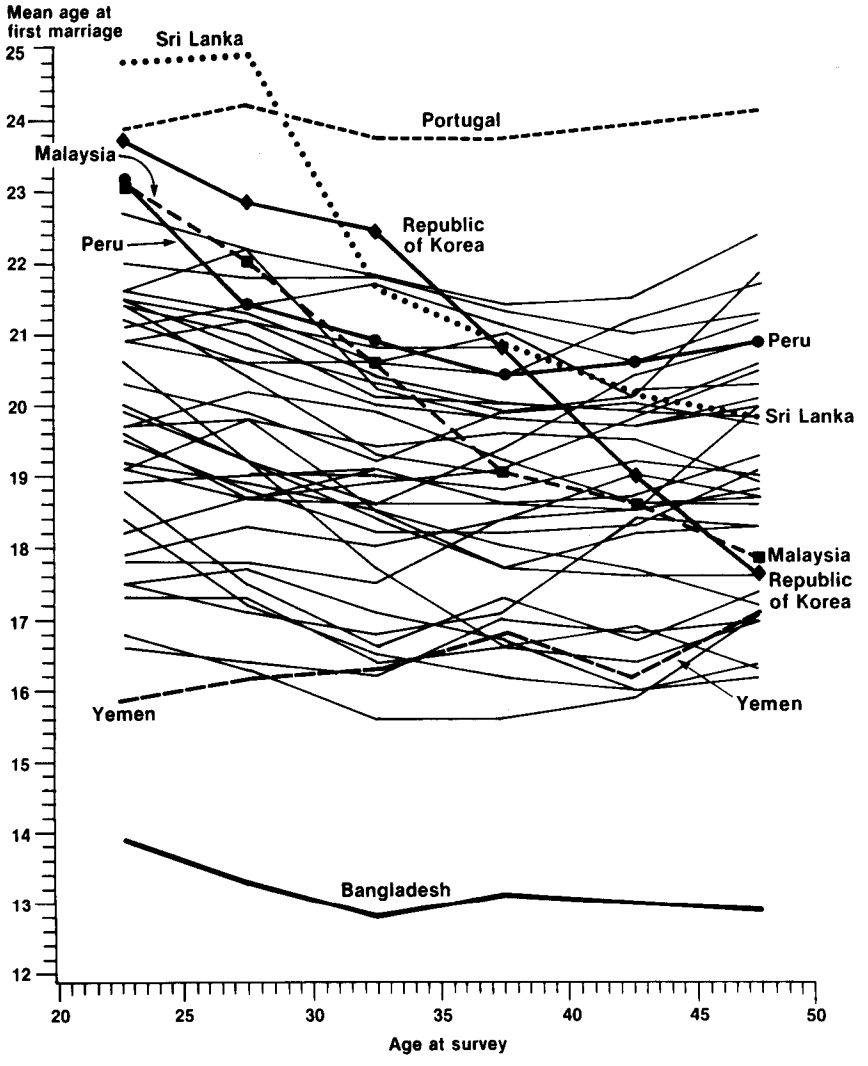


Figure I-A. Mean age at first marriage, by cohort

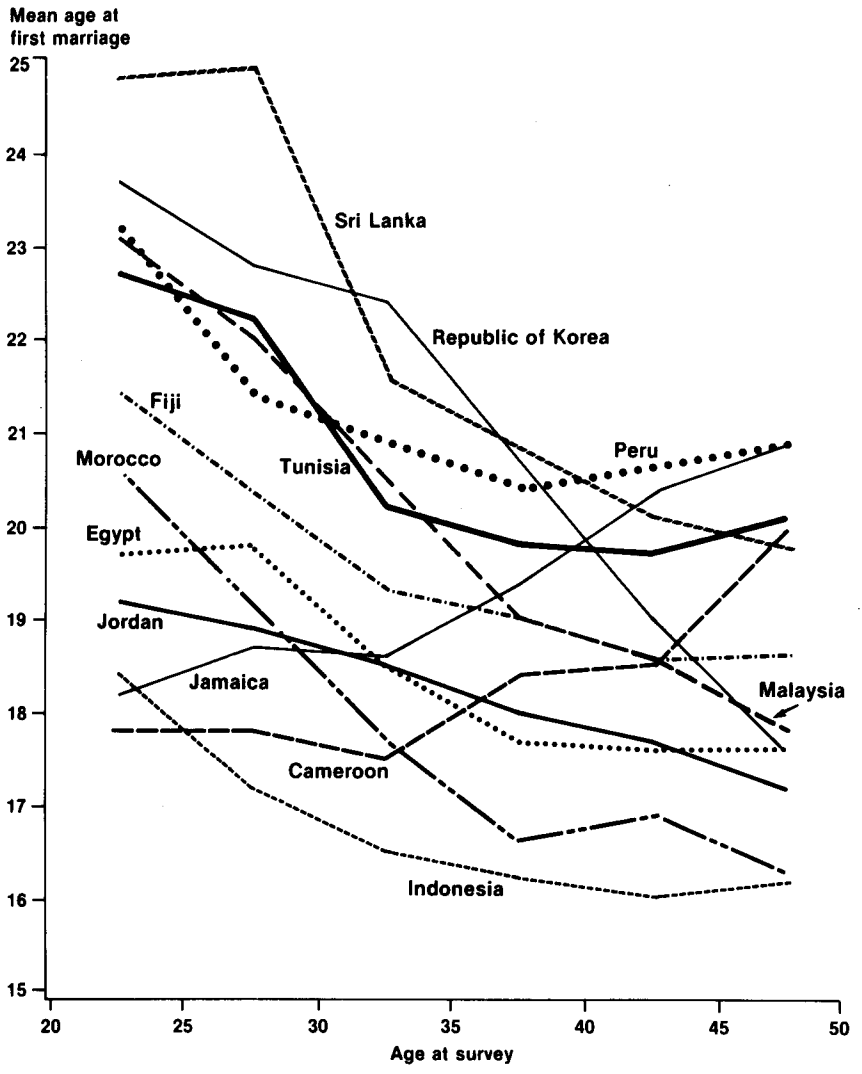
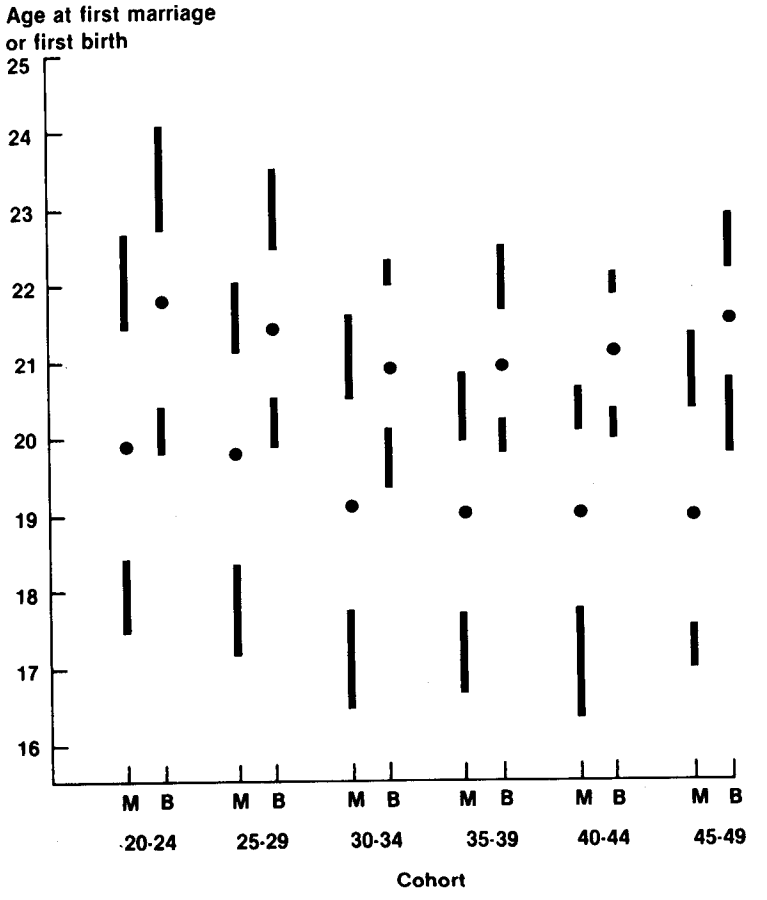


Figure I-B. Distributions across populations of mean ages at first marriage and first birth, by cohort



NOTES:
M = first marriage, B = first birth.
The dot signifies the median value.
The solid lines extend from the quartiles to the eighths.

Figure II. Standard deviation of first marriage, by cohort

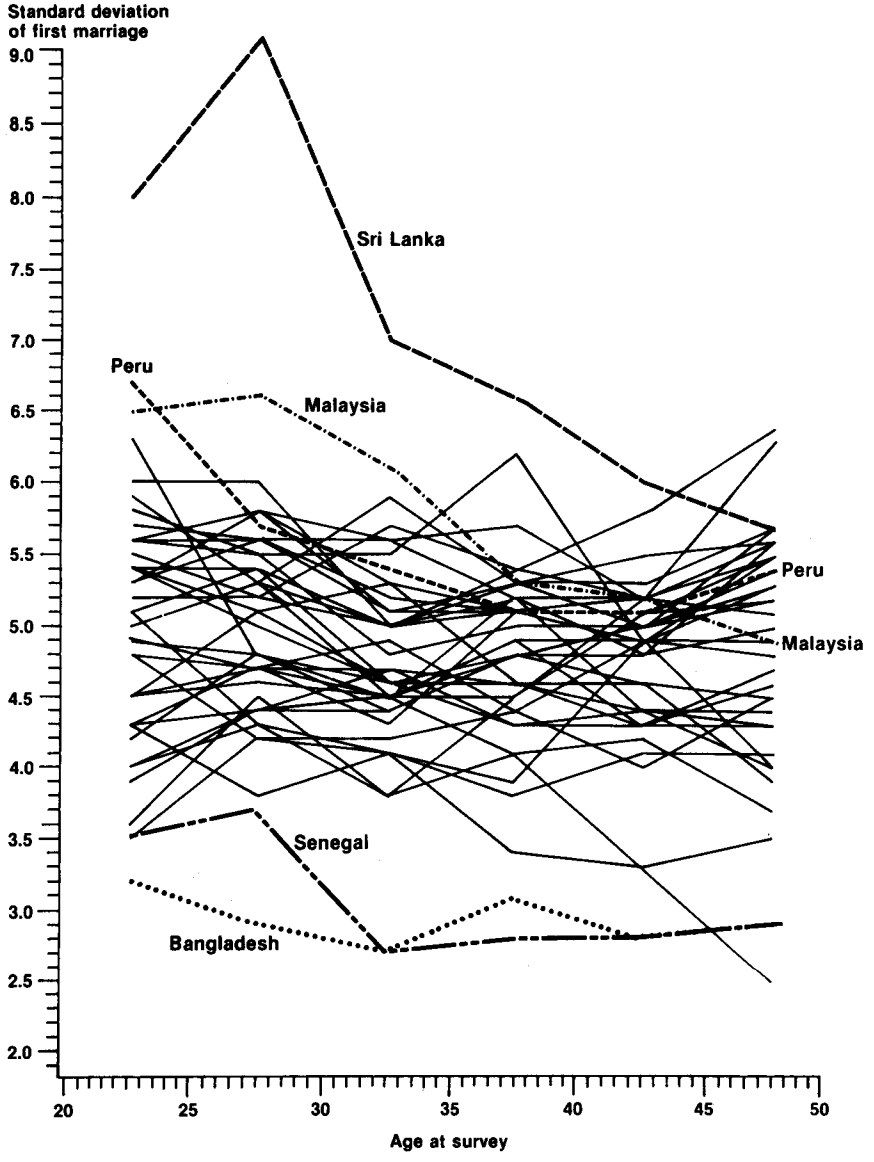


Figure II-A. Standard deviation of age at first marriage, by cohort

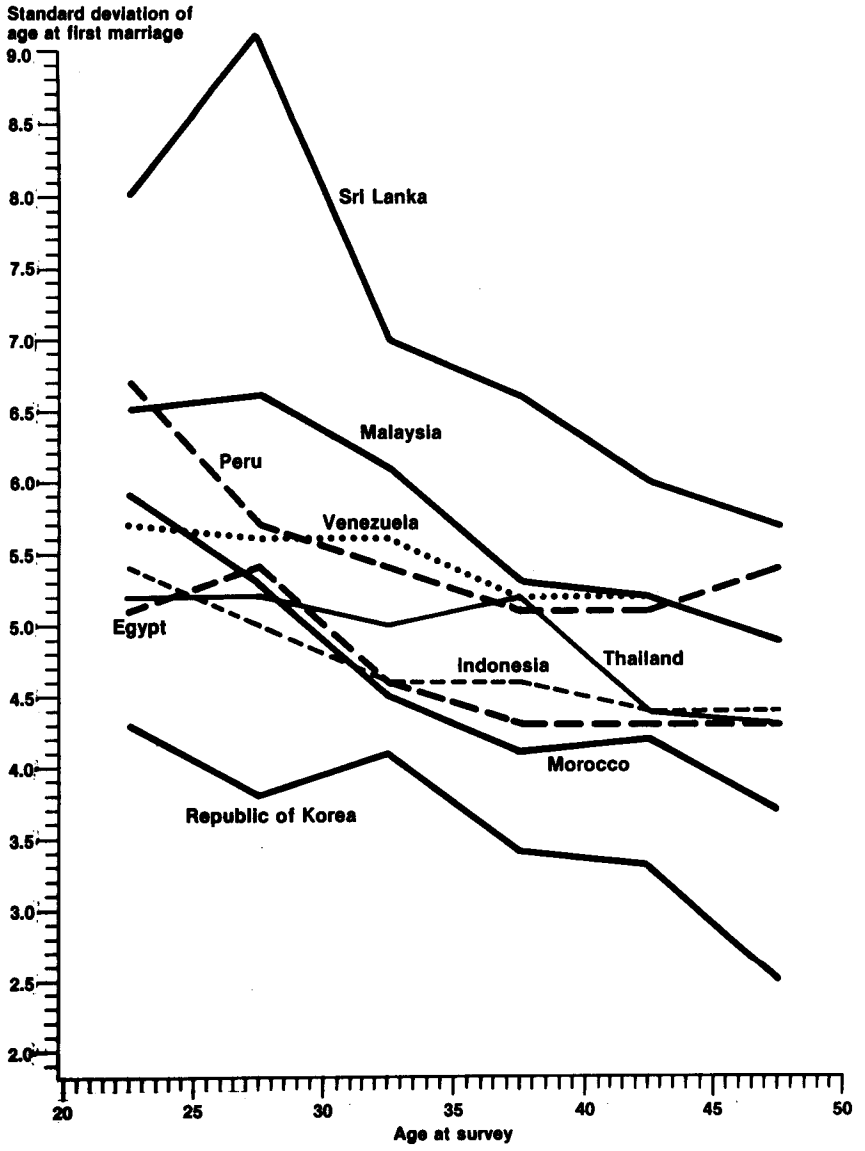


Figure III. Proportion ever marrying, by cohort

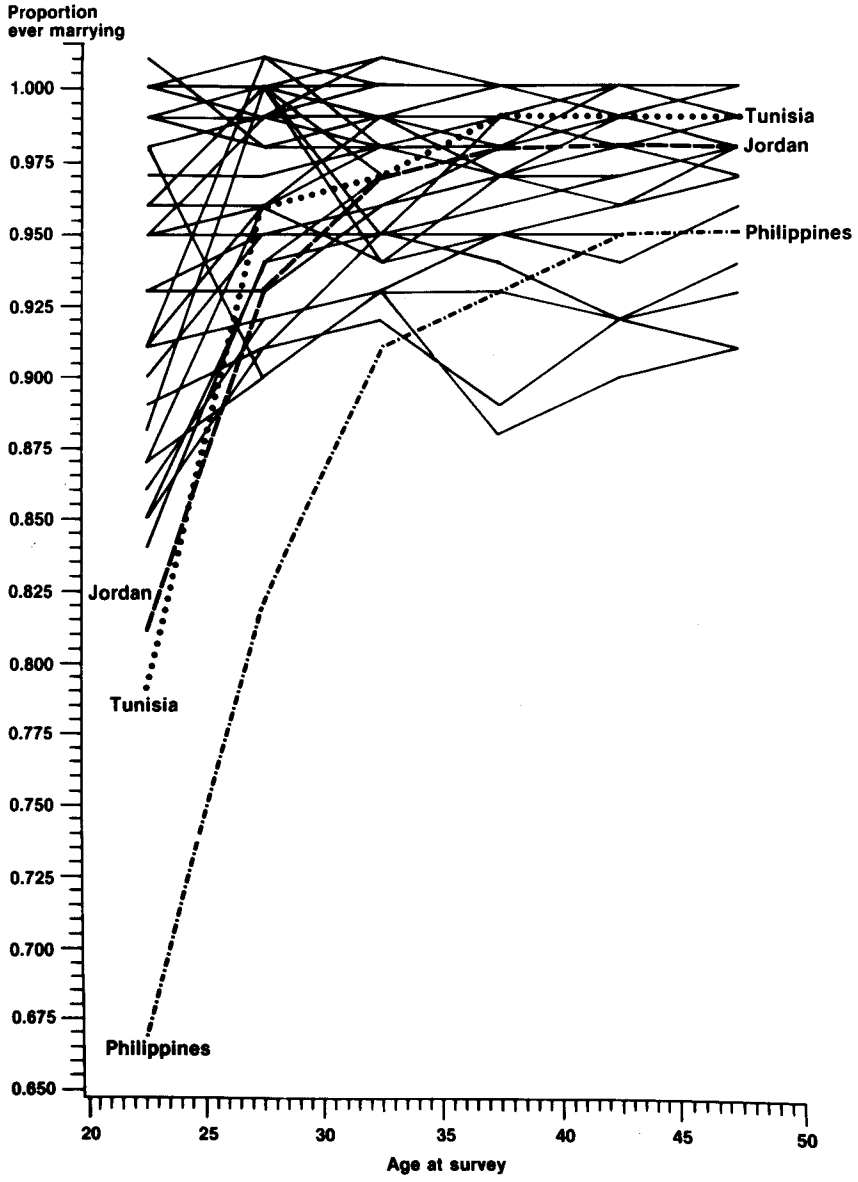
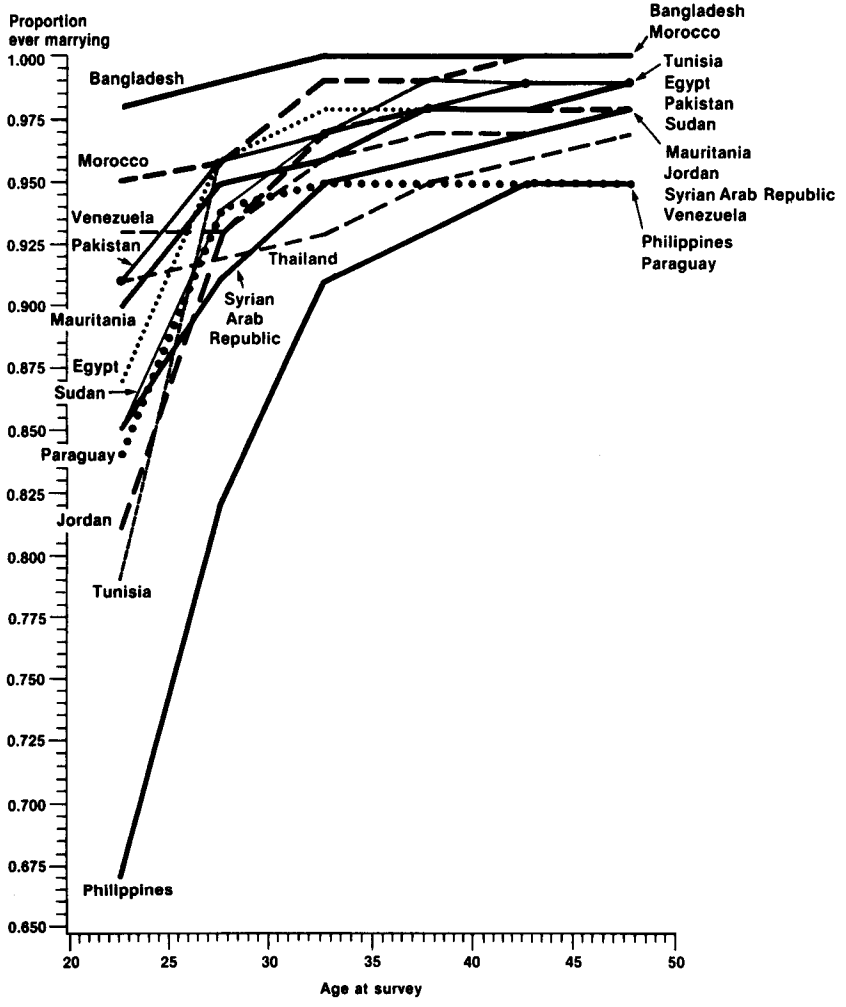


Figure III-A. Proportion ever marrying, by cohort



(Bangladesh, Jordan, Morocco, Pakistan, Paraguay, Philippines, Sudan, Syrian Arab Republic, Thailand, Tunisia and Venezuela), though in many of them the decline has been small and not statistically significant. In several populations, the estimated proportion who will ever marry is at least .05 lower for the youngest than for the next youngest cohort—Egypt (.96 to .87),[2] Jordan (.93 to .81), Mauritania (.95 to .90), Paraguay (.94 to .84), Philippines (.82 to .67), Sudan (.94 to .85) and Tunisia (.96 to .79). The estimated decline is far too large to be believable for any of those, in our opinion, though we would accept a decline of smaller magnitude in all of them. We hasten to add, however, that a smaller decline implies that the rise in the mean age at marriage will be even greater, as is shown in annex III. For example, raising PEM in the cohort aged 20-24 would rotate the cumulative schedule of proportions ever married counter-clockwise about the age group 20-24. That rotation raises the mean. Hence, in those situations one has a choice between a low value of PEM and a relatively low mean or a higher value of PEM and a relatively higher mean.

Age at first birth and proportions ever having children

Estimated trends in the mean age at first birth are shown in figure IV. As we saw earlier in figure I, two countries bracket the experience of all the others. In Bangladesh, mean age at first birth is below 18 years (except for the oldest cohort). We strongly suspect that the decline in the oldest three cohorts (from 18.1 for those 45-49 to 17.4 for those 35-39) is not real, but due instead to a tendency that increases with the age of the woman to omit first births (especially if they died). Moreover, if the reported estimate of the mean age at menarche in Matlab Thana (15.7) approximates the mean for the country as a whole and if there really is a period of adolescent subfecundity, then the mean ages at first birth for all cohorts appear to be too low. We nevertheless have no doubt that age at first birth in Bangladesh is lower than in any of the other 40 populations surveyed by WFS. Portugal provides the other extreme, with a mean age at first birth that exceeds 25 for all cohorts. Ignoring the two extremes, we note that age at first birth seems to be more heterogeneous across populations in the younger cohorts than in the older cohorts.[3] For each cohort, the mean age at first birth is more homogeneous across populations than is the mean age of marriage (see figure I-B).

Those populations which display pronounced time trends are shown separately in figure IV-A. In eight populations (Egypt, Fiji, Malaysia, Morocco, Republic of Korea, Sri Lanka, Trinidad and Tobago, and Tunisia), the estimated rise in the mean age at first birth from the oldest to the youngest cohort exceeds 1.5 years, and in five of them (Egypt, Malaysia, Morocco, Republic of Korea and Sri Lanka) the rise across cohorts is monotonic or nearly so. The increases are most spectacular in the Republic of Korea (20.7 to 25.1), Malaysia (20.4 to 24.1) and Sri Lanka (21.6 to 25.8). In two countries there is a decline from the oldest to the youngest cohort of more than two years (Cameroon and Nigeria), and in Nigeria the decline is actually monotonic (starting at 22.9 among those 45-49 and falling to 20.0 among those 20-24). As in the case of Bangladesh, we strongly suspect that older women tended to omit first births more than

Figure IV. Mean age at first birth, by cohort

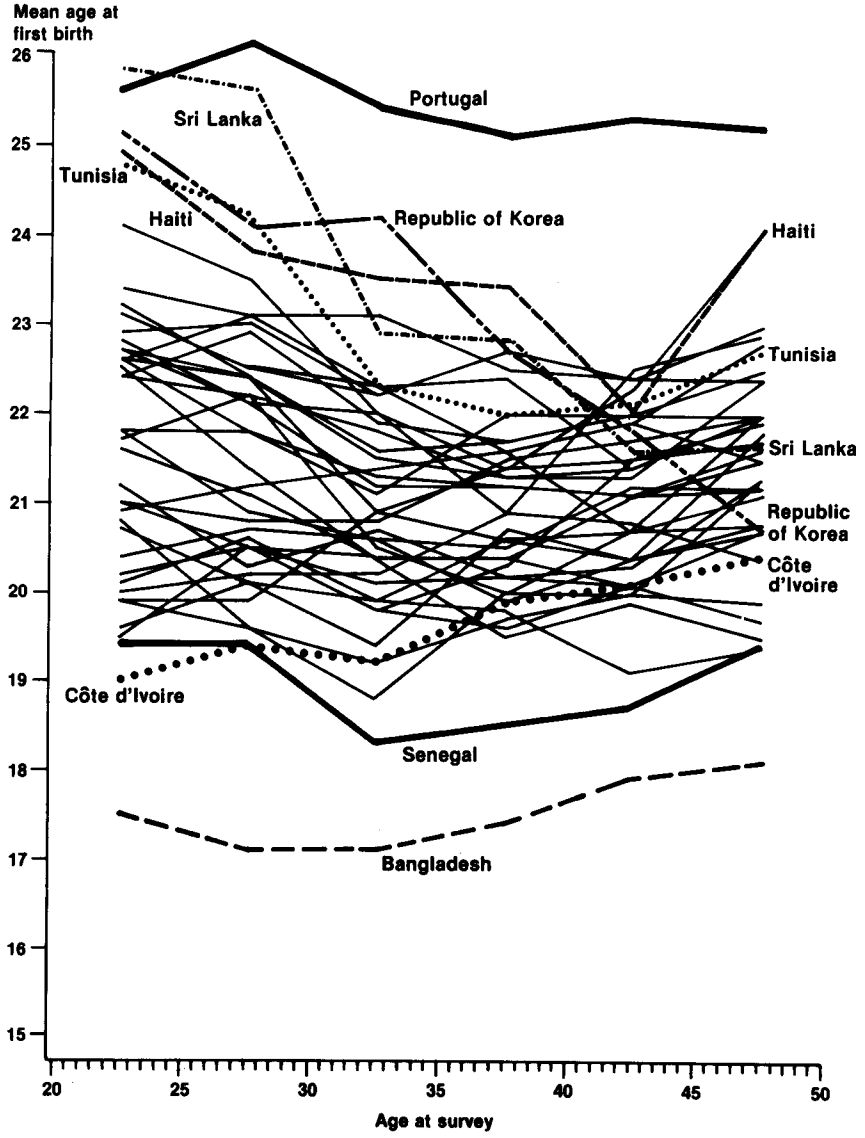
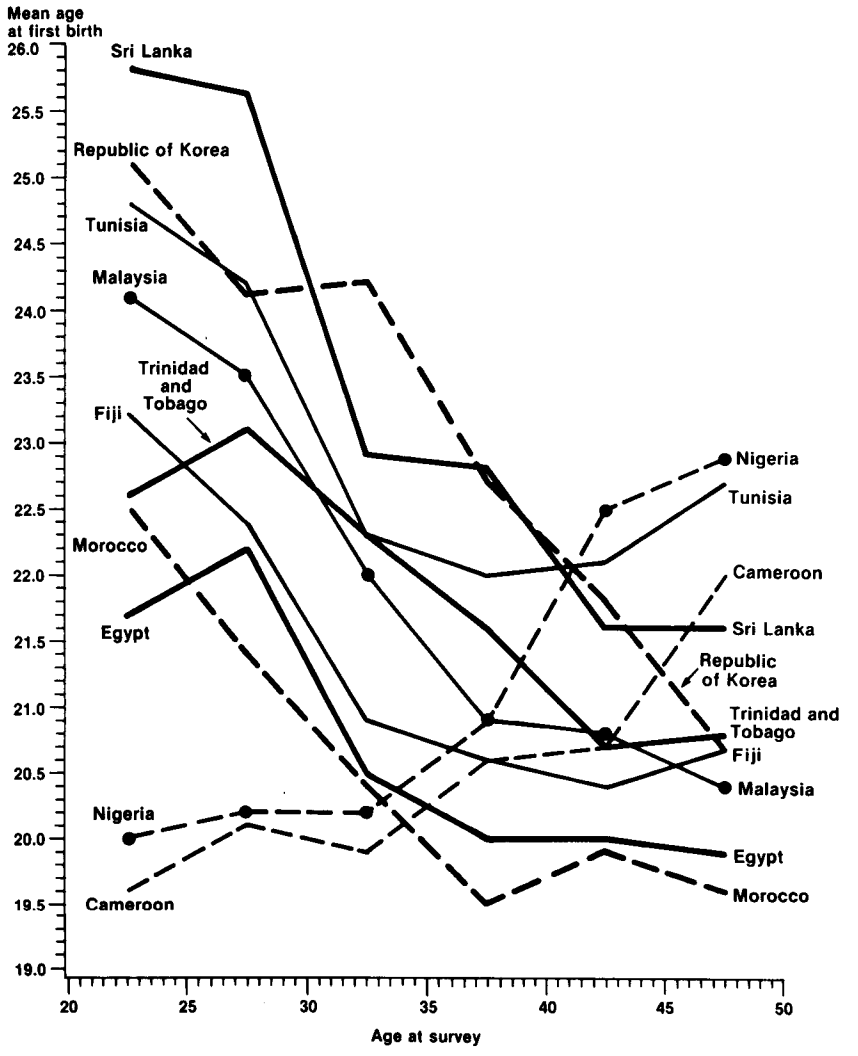


Figure IV-A. Mean age at first birth, by cohort



younger women, so that the decline is an artifact of the data. We suspect that the same problem exists in the majority of countries; in 21 populations the mean age at first birth rises for the older cohorts (Bangladesh, Benin, Cameroon, Colombia, Costa Rica, Côte d'Ivoire, Dominican Republic, Ecuador, Haiti, Indonesia, Jamaica, Kenya, Mauritania, Nepal, Nigeria, Philippines, Senegal, Sudan, Tunisia, Turkey and Yemen).

The estimated time trends in the standard deviation of age at first birth are displayed in figure V; the plots for most countries show no consistent trend. There is a tendency for greater heterogeneity over time in age at first birth in Egypt, Malaysia, Morocco, Republic of Korea and Sri Lanka;[4] the trends for those countries are shown separately in figure V-A. Age at first birth is (and has been) most homogeneous in Bangladesh and Senegal ($\sigma < 4$) and appears to be most heterogeneous in Sri Lanka and recently in Haiti ($\sigma > 6.5$).

Finally, we shown in figure VI the estimated time trends in the proportion ever having children. In 30 countries, the proportion is .90 or higher in every cohort. In 10 countries the proportion is .95 or higher in every cohort, and in five of them (Bangladesh, Ghana, Kenya, Republic of Korea and Yemen) the proportion exceeds .97 in every cohort. Likewise, the proportions reach very high levels in many cohorts for other populations. Among women over age 35, the estimated proportions are not artifacts of the model; they reflect faithfully the proportions in the data.[5] Since proportions that high approach—or exceed—physiological limits, one might well question whether there was some systematic defect in the execution of the surveys conducted by WFS whereby women without children were under-represented.

There is a slight tendency towards a smaller proportion ever bearing a child among the younger cohorts in several countries; moreover, the estimated decline is large, and unbelievable, in Egypt (from .96 at 25-29 to .86 at 20-24),[2] Jamaica (from 1.0 to .89), Jordan (from .93 to .76), Pakistan (from .93 to .86), Philippines (from .82 to .75), Sri Lanka (from .92 to .84) and Sudan (from .93 to .83). In both Peru and Sri Lanka, the decline in both of the youngest two age groups seems excessive. Time trends for those countries with pronounced changes in the proportions ever bearing children are shown in figure VI-A. We note, however, that if we impose a higher proportion ever having a birth and re-estimate the remaining parameters in the model (μ and σ), the estimated rise in the mean age at first birth will be even greater. The results of such an exercise are given in annex III.

Relations among the parameters

We next explore whether there are empirical regularities among the parameters estimated for the marriage models and for the models of first birth. We do so for two reasons. First, we would expect positive associations between means and standard deviations, given social norms, for purely statistical reasons. If the mean is small, then the standard deviation should be small because there are lower age limits (socially imposed for marriage and socially or biologically imposed for birth) that force a concentration of the timing of the events. On the other hand, we have no reasons, either statistical or behavioural, to expect especially strong associa-

Figure V. Standard deviation of first birth, by cohort

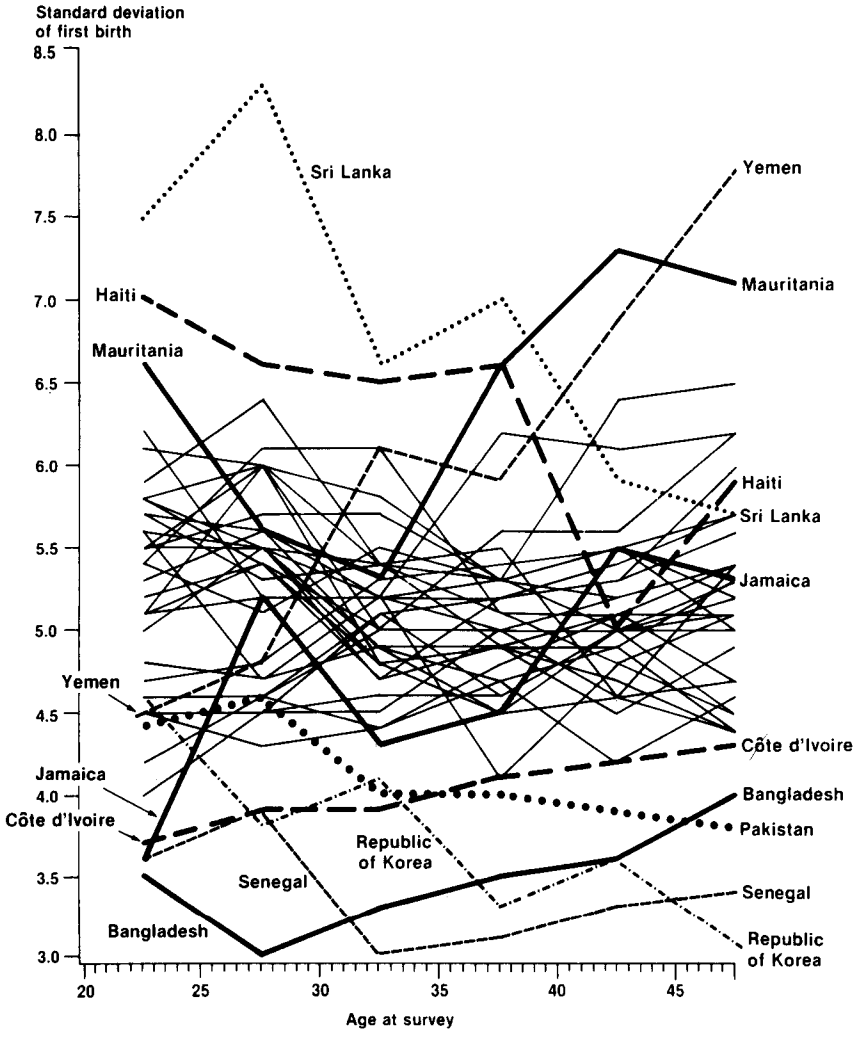


Figure V-A. Standard deviation of age at first birth, by cohort

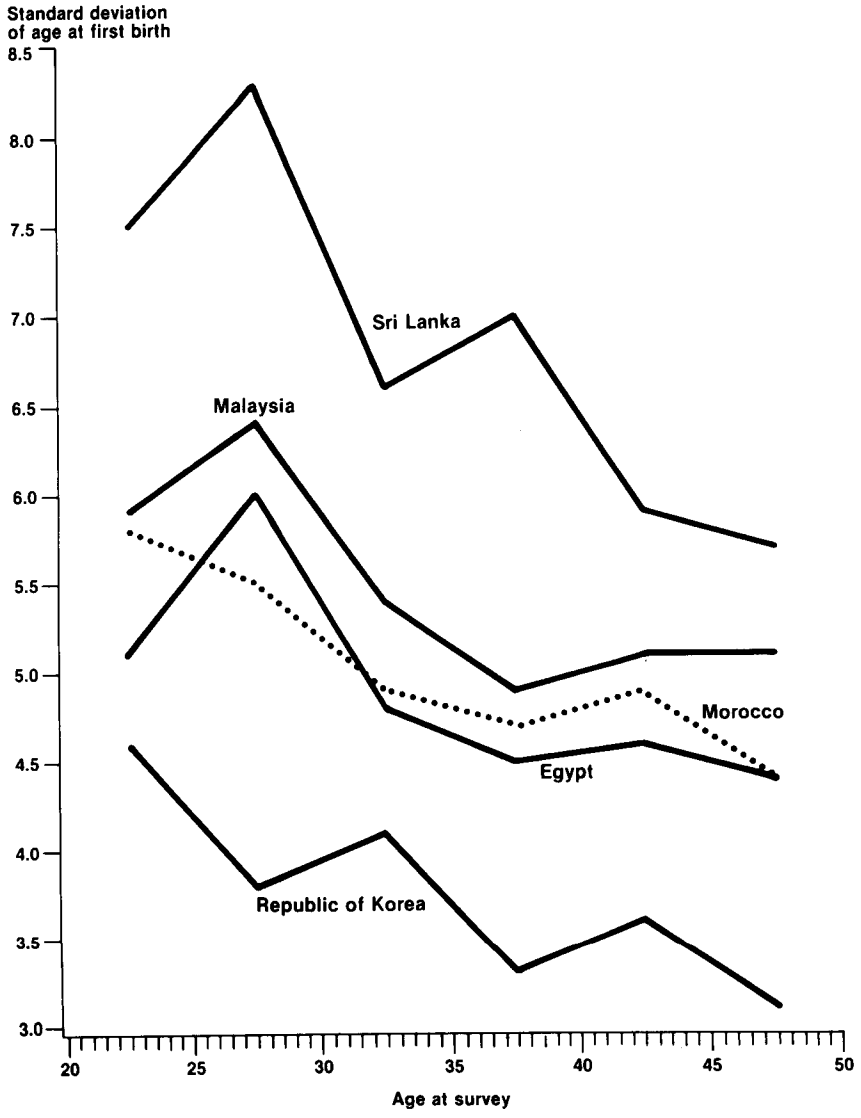


Figure VI. Proportion ever having a birth, by cohort

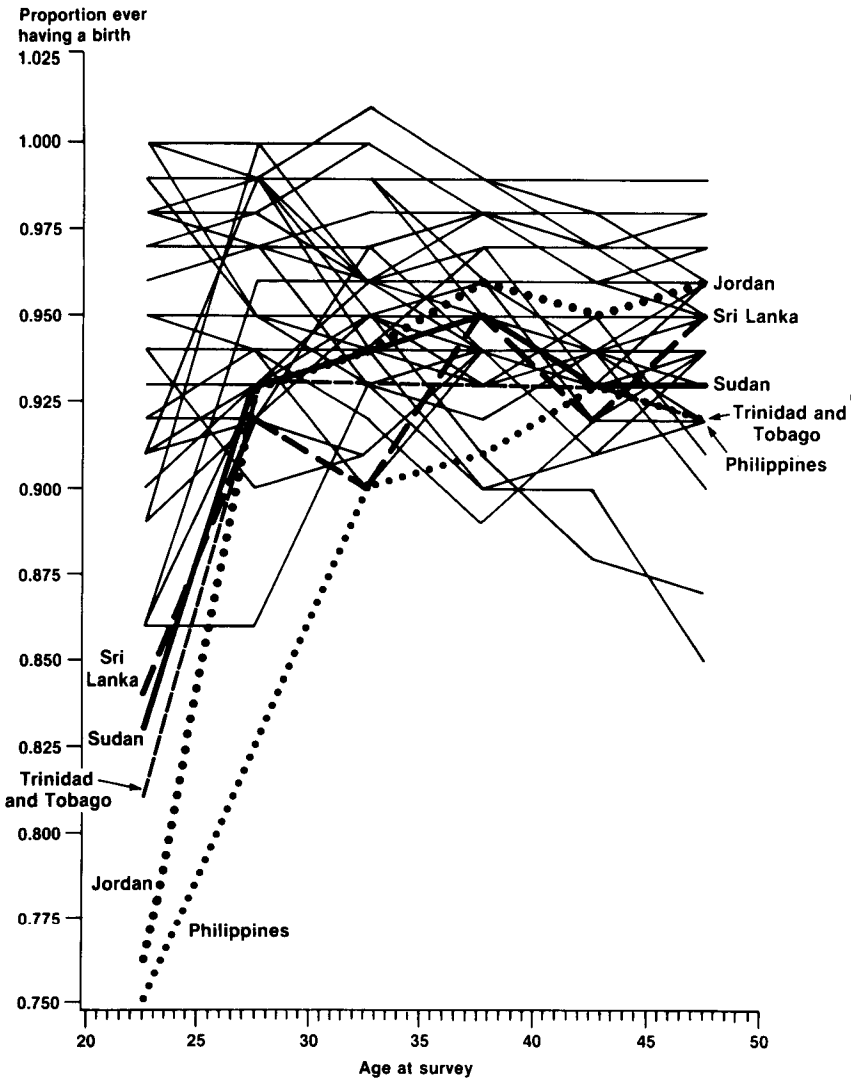
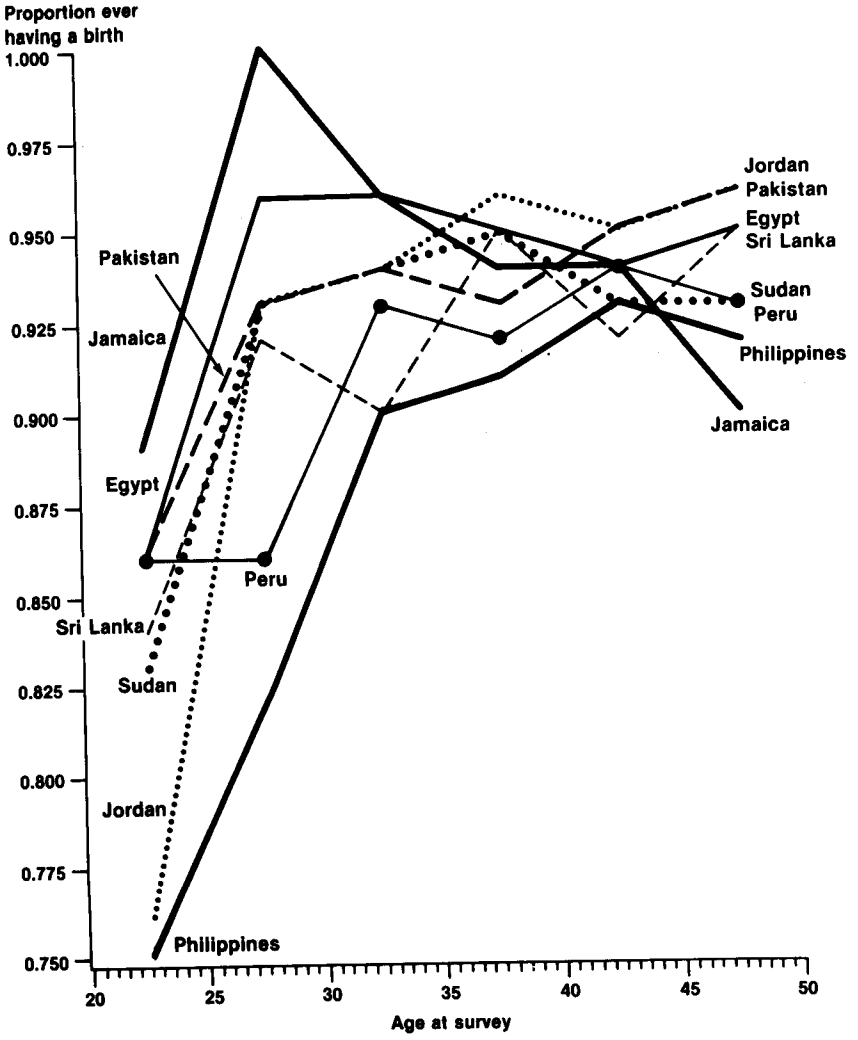


Figure VI-A. Proportion ever having a birth, by cohort



tions between the proportion experiencing the event and the other two parameters. Theory, however, tells us little about the precise magnitude of such associations. Secondly, if there are strong empirical regularities, then it might be possible to reduce the number of parameters in the models of first marriage and birth. If, for example, σ always equalled $.4\mu$, then the number of parameters could be reduced from three to two.

In figures VII to IX we examine the results for age at first marriage. In figure VII, the estimates of the standard deviation of age at marriage (σ_M) are plotted against the estimates of the mean age at marriage (μ_M); each country contributes one point for each cohort. There one can see a tendency for higher means to be associated with higher standard deviations; the correlation between the two is $+.70$. We have also plotted the regression line which best summarizes the association between the two:

$$\sigma_M = -0.323 + 0.268\mu \qquad R^2 = .49 \qquad (2)$$
$$(.484) \quad (.025)$$

where the estimated standard errors of the coefficients are given in parentheses below the coefficients.

There is much less association between the proportion ever marrying and the standard deviation of age at marriage, as is clearly evident from figure VIII. The correlation between the two is only $-.40$. The regression line summarizing the relation is

$$\sigma_M = 11.159 - 6.579 \text{ PEM} \qquad R^2 = .16 \qquad (3)$$
$$(1.309) \quad (1.362)$$

Likewise, as can be seen from figure IX, there is only a weak association between the proportion ever marrying and the mean age at first marriage; the correlation between the two is $-.41$. The regression summarizing the association is

$$\text{PEM} = 1.153 - 0.010\mu_M \qquad R^2 = .18 \qquad (4)$$
$$(0.038) \quad (0.002)$$

In figures X to XII, we repeat the same exercise for age at first birth. In figure X, the estimates of the standard deviation of age at first birth (σ_B) are plotted against the estimates of the mean age at first birth (μ_B). The association is somewhat weaker than was the case for first marriage ($\rho = .60$ for births vs. .70 for marriage), but a definitive positive relation is evident. The regression line summarizing the association is

$$\sigma_B = -2.157 - 0.341\mu_B \qquad R^2 = .37 \qquad (5)$$
$$(0.872) \quad (0.041)$$

The association between the proportion ever having a birth and either the mean age at first birth ($\rho = -.30$) or the standard deviation of age at first birth ($\rho = -.18$) is even weaker than the association found for first marriage. The regressions summarizing the relations are

$$\sigma_B = 9.735 - 4.876 \text{ PFB} \qquad R^2 = .03 \qquad (6)$$
$$(2.280) \quad (2.403)$$

Figure VII. Standard deviation of first marriage vs. mean age at first marriage

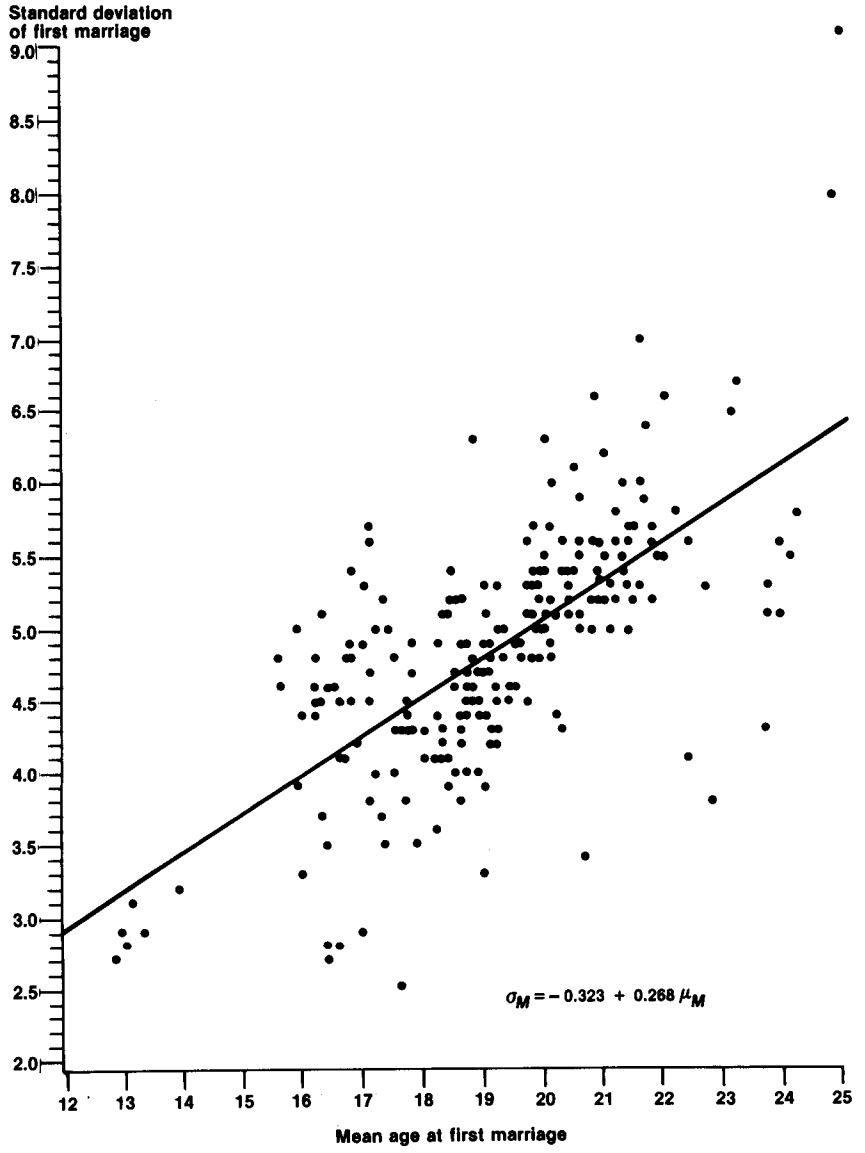


Figure VIII. Standard deviation of first marriage vs. proportion ever marrying

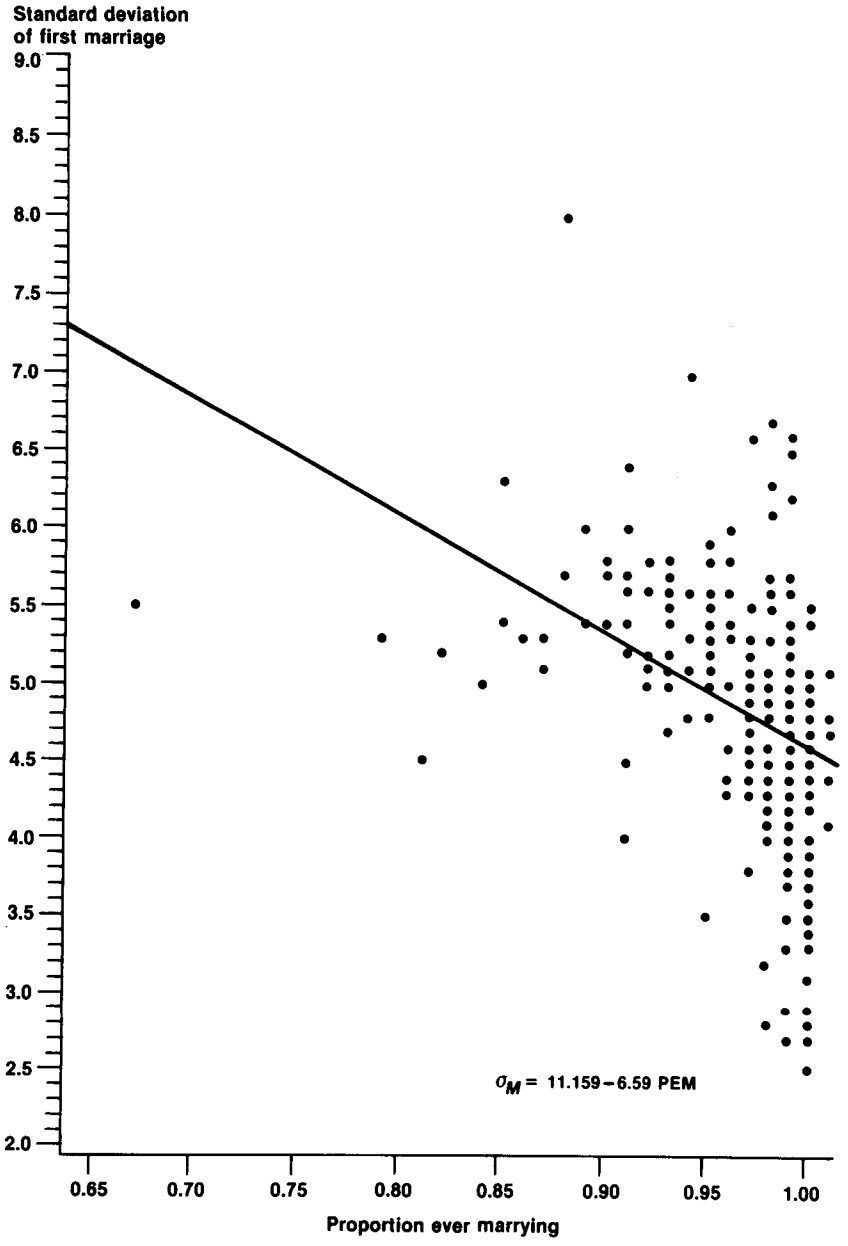


Figure IX. Proportion ever marrying vs. mean age at first marriage

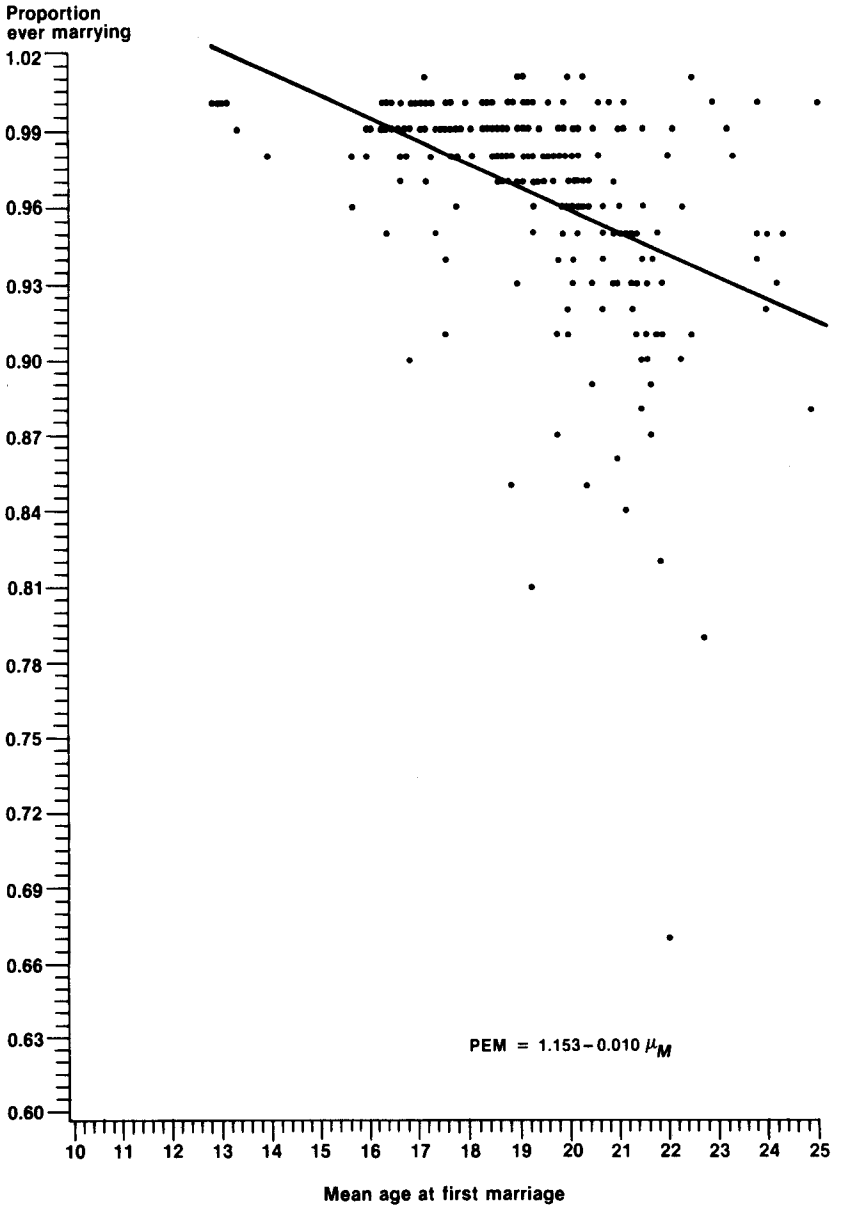


Figure X. Standard deviation of first birth vs. mean age at first birth

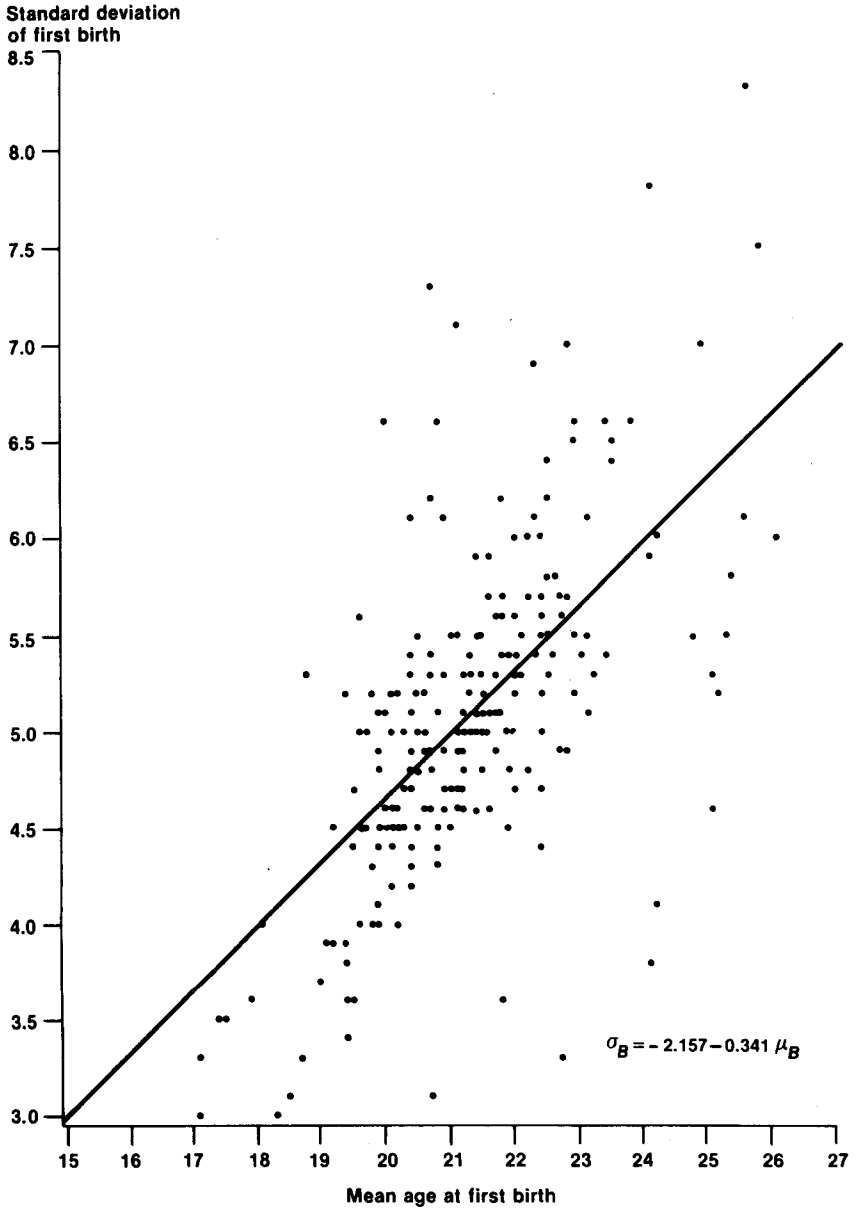


Figure XI. Standard deviation of first birth vs. proportion ever having a birth

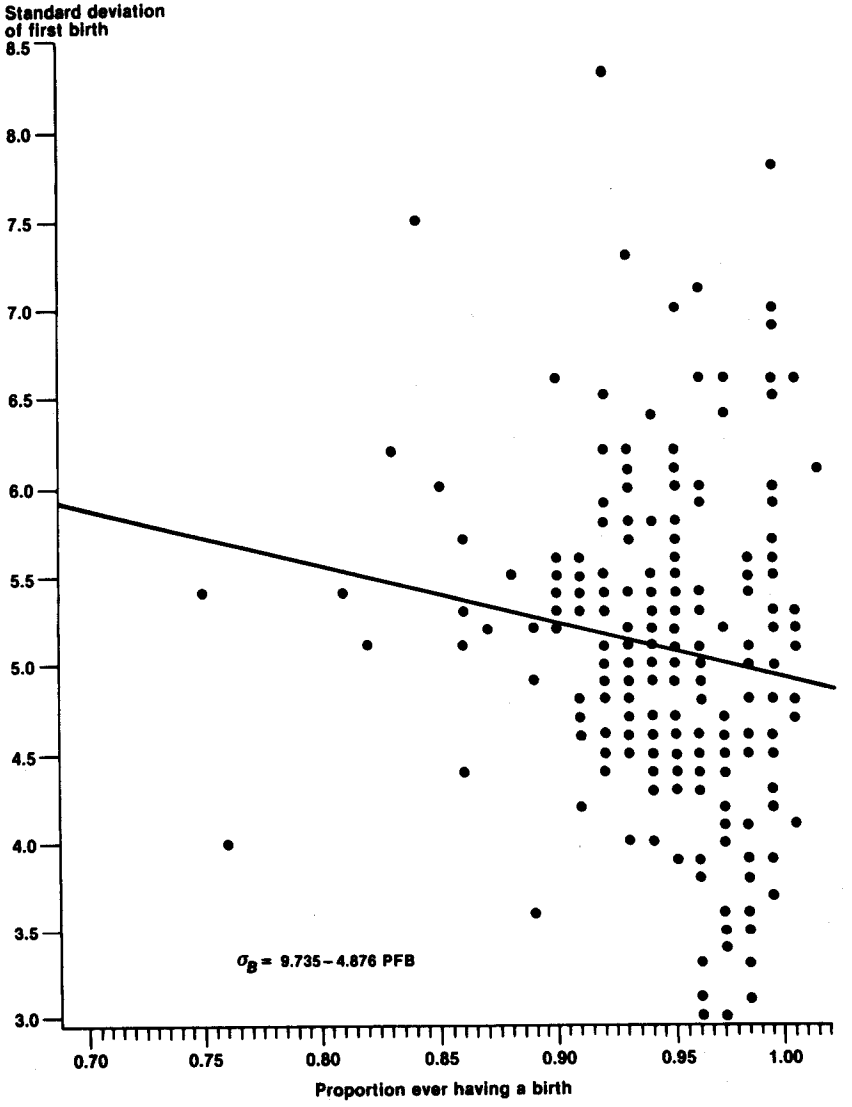
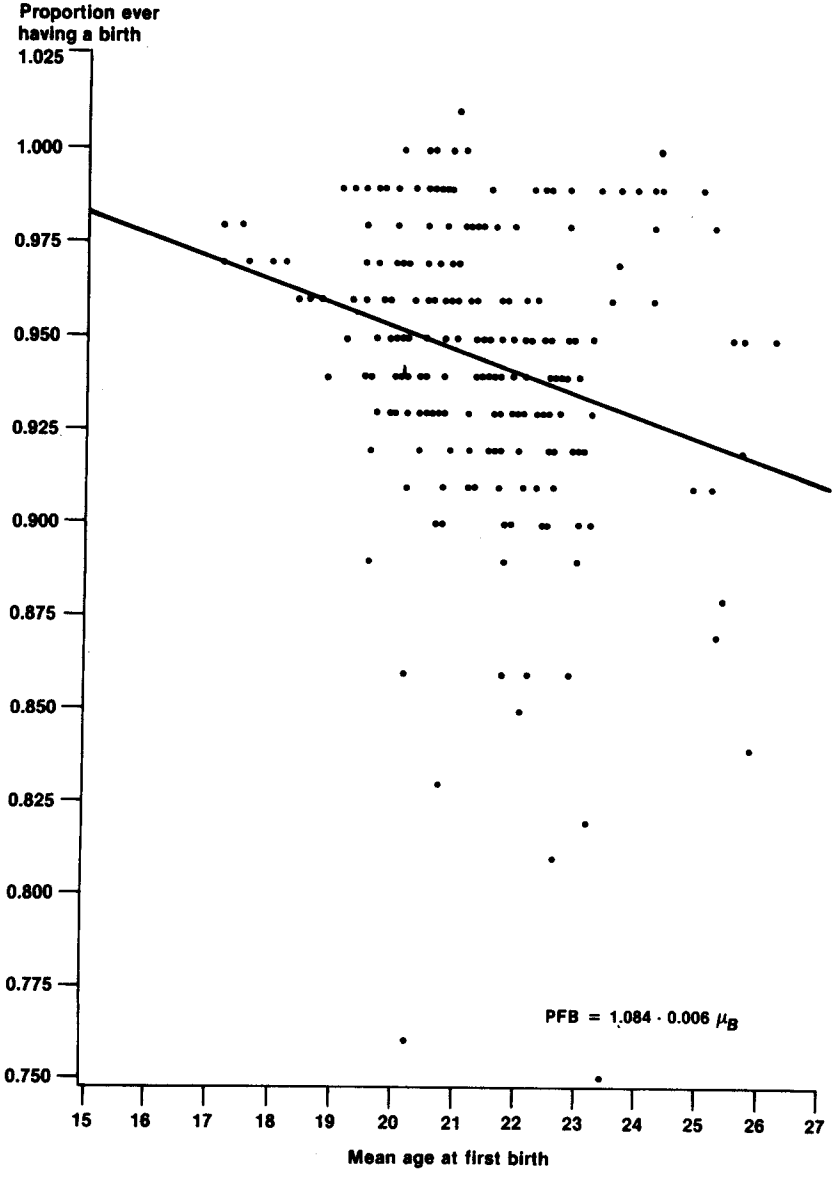


Figure XII. Proportion ever having a birth vs. mean age at first birth



$$\text{PFB} = 1.084 - 0.006\mu_B \qquad R^2 = .09 \qquad (7)$$
$$(0.039) \quad (0.002)$$

Finally, we turn to an examination of the relation between the age at first birth and first marriage (μ_B and μ_M), the standard deviation of age at first birth and first marriage (σ_B and σ_M), and the proportions ever having a birth and marrying (PEB and PEM). As is evident from figure XIII, there is a strong positive association between the mean age at first birth and the mean age at first marriage ($\rho = .81$). The regression summarizing the relation is

$$\mu_B = 10.415 + 0.566\mu_M \qquad R^2 = .66 \qquad (8)$$
$$(0.720) \quad (0.037)$$

Hence, among the 41 countries studied, a rise of one year in the mean age at marriage is associated with a rise of .6 year in the mean age at first birth. In only one cohort in one population is the mean age at first birth less than the mean age at first marriage (Peru, 20-24), and that one observation occurs in the youngest cohort where the estimates are least reliable, especially since the estimated means are so high.

There is also a strong positive association between the standard deviations of age at first birth and first marriage, as can be seen in figure XIV ($\rho = .72$). The regression summarizing the relation is

$$\sigma_B = 1.522 + 0.741\sigma_M \qquad R^2 = .52 \qquad (9)$$
$$(0.317) \quad (0.064)$$

Thus, there is a tendency for marriage to be more spread out than first birth when σ_M is above 5.9 and for marriage to be less spread out when σ_M is below 5.9; moreover, an increase of 1 in σ_M is associated with an increase of only .74 in σ_B.

The association between proportions having a birth and proportions ever marrying is much weaker, as is evident from examination of figure XV. The two are positively correlated, though ρ is small ($\rho = .43$). The regression summarizing the association is

$$\text{PFB} = 0.689 + 0.270\ \text{PEM} \qquad R^2 = .19 \qquad (10)$$
$$(0.049) \quad (0.051)$$

The lack of association is not so surprising when one recalls that in the vast majority of cohorts, both proportions lie above .90. More surprising, at least at first glance, is the number of cohorts for which the estimated proportion ever having a birth exceeds the estimated proportion ever marrying. However, of the 29 cohorts in 13 countries in which that circumstance obtains, most differences are quite small and only one (Jamaica, 20-24) is statistically significant. Even that difference is almost certainly not real, since it is based on extrapolation from the youngest cohort.

Conclusions

In this report we have presented estimates of parameters of models for age at first marriage and age at first birth at the national level for 41

Figure XIII. Mean age at first birth vs. mean age at first marriage

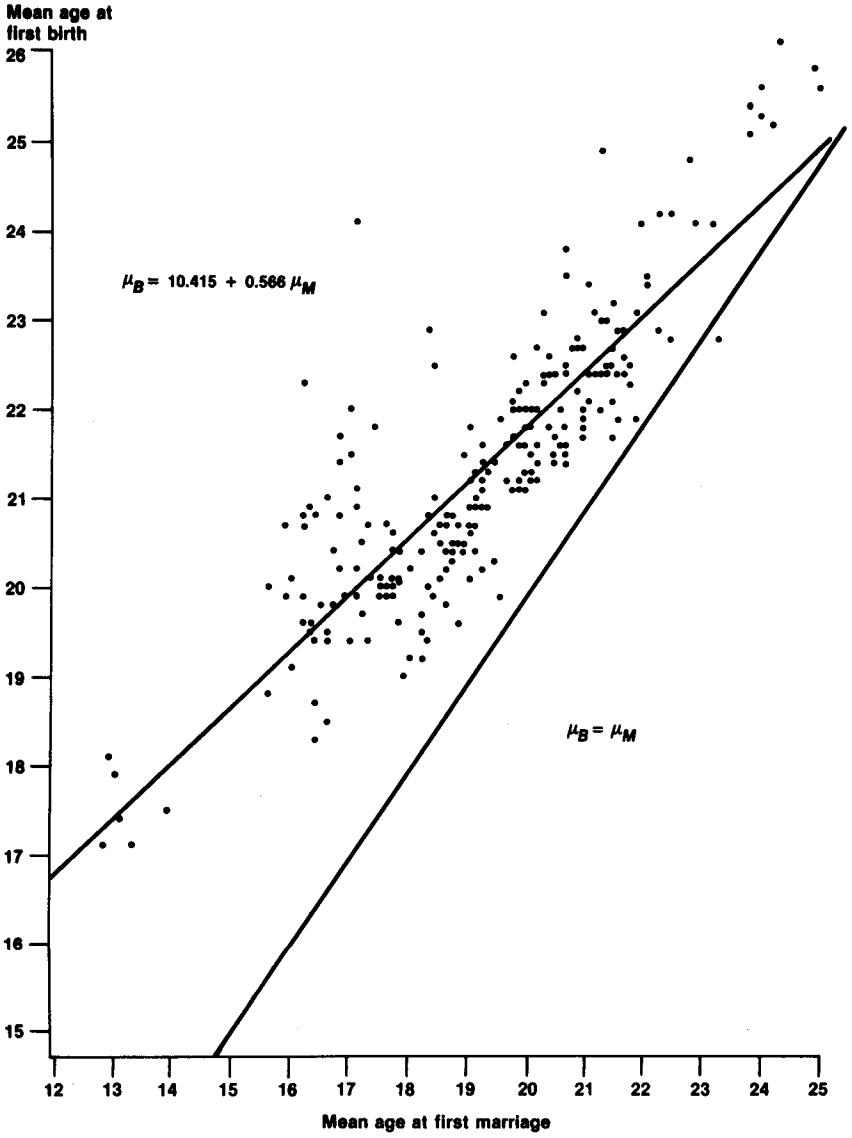


Figure XIV. Standard deviation of first birth vs. standard deviation of first marriage

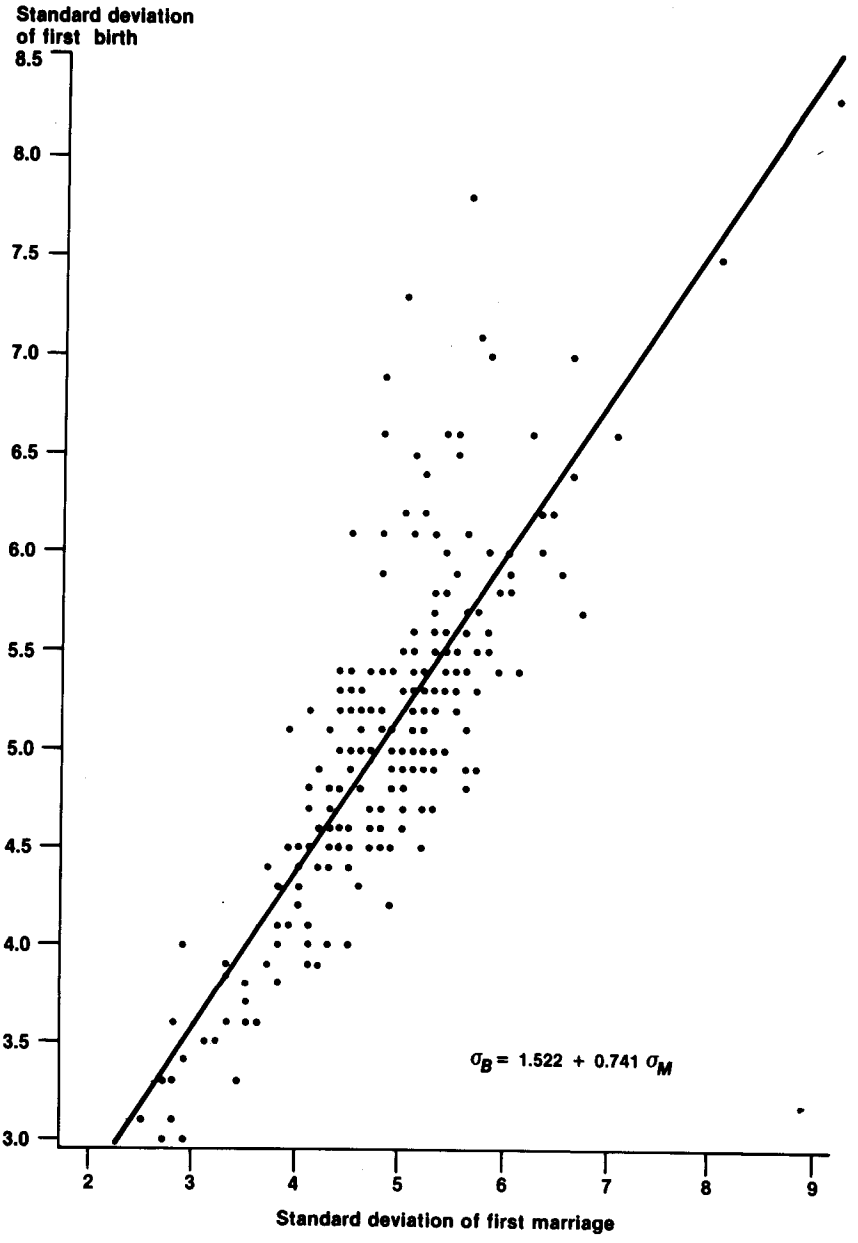
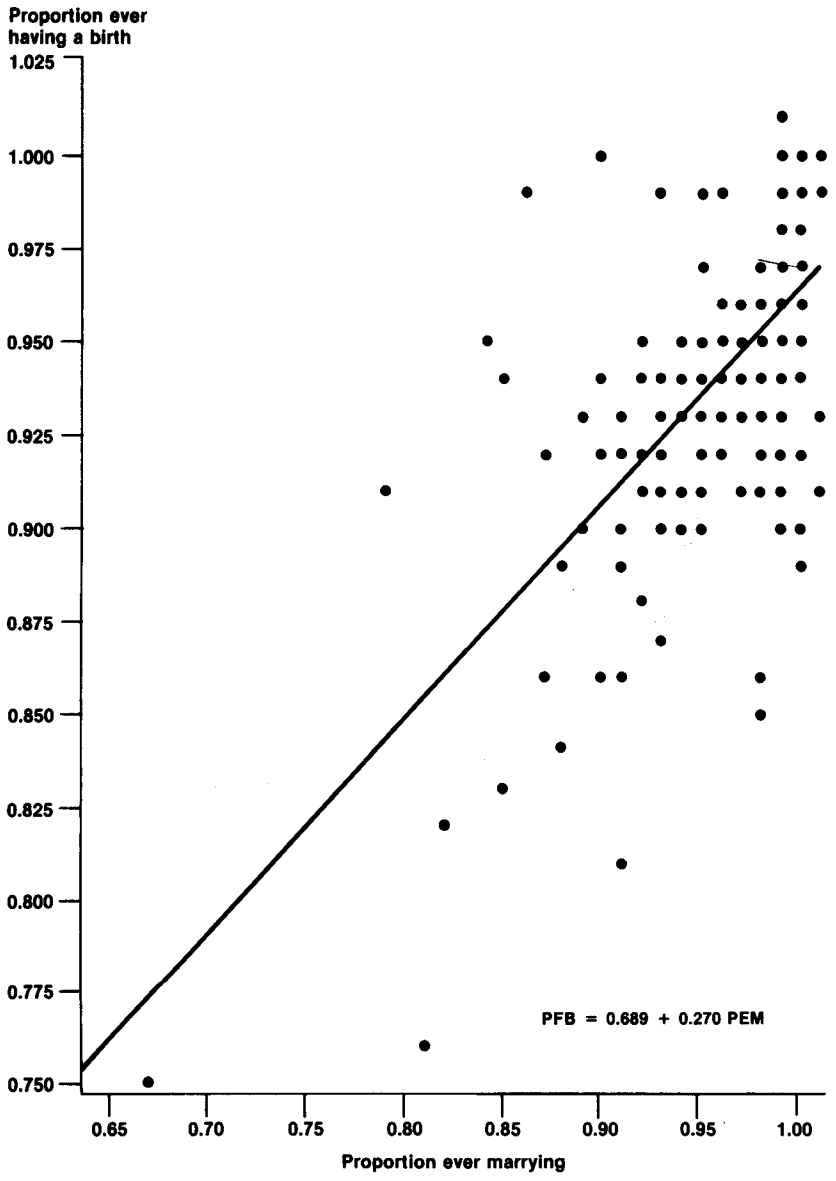


Figure XV. Proportion ever having a birth vs. proportion ever marrying



countries in which surveys were conducted by the World Fertility Survey. For each of six standard five-year age cohorts we estimated the proportions who will ever marry and the mean and standard deviation of age at marriage among those who will ever marry. Likewise, we estimated the proportion who will ever bear a child and the mean and standard deviation of age at first birth among those who will ever bear children.

Our results suggest two conclusions about the quality of data on age at first birth.

(*a*) There is strong evidence of a tendency for women in the older cohorts to omit the first birth or at least to report its occurrence at a later date than it really happened. In over half of the countries we examined, the mean age at first birth fell over time in the oldest two or three cohorts; we interpret this fall as an artifact of the data rather than an actual trend.

(*b*) There is evidence of a flaw in the field execution of the WFS sampling scheme whereby women with no children were under-represented. The evidence for the assertion is that the proportion ever bearing a child in the oldest cohorts, where no extrapolation is necessary, often exceeds 98 per cent, which seems to us a plausible physiological maximum.[6] Our best guess is that the problem arises either because childless women were not reported to the interviewer (perhaps because they occupy a marginal position of low status) and thus could not have been selected for our interview or because childless women report adopted children as their own children.

Strong conclusions about the quality of data on age at marriage are harder to obtain because our prior expectations are considerably skimpier. We have one bit of evidence that suggests that WFS may not have been successful in obtaining accurate ages at which women began to have sexual relations with their husbands in societies in which the formal marriage ceremony may precede cohabitation by some considerable time. The evidence is confined to Bangladesh, where the mean reported age at the start of "joining with the husband" is considerably lower than an independent estimate of the mean age at menarche. Because marriage does not occur at such an early age in any other surveyed population, we have no way of knowing whether age at marriage was systematically under-reported in other countries.

We are able to document wide variation across countries in both the mean ages at first marriage and first birth and the standard deviations of age at first marriage and first birth. Those variations are so wide that they could not be caused solely by defects in the data. Variations in the proportions ever marrying and ever having a birth are smaller, though they do exist.

We are also able to show that behaviour has changed rather markedly over time in several countries, the most important examples being Malaysia, Morocco, the Republic of Korea and Sri Lanka. In those countries the mean ages at marriage and first birth have risen and the standard deviations have become larger (indicating that each population has become more heterogeneous) over time.

In the majority of countries, however, behaviour has changed little from the oldest to the youngest cohort. Such countries include all those we examined in sub-Saharan Africa, South Asia, Latin America and the Carib-

bean (except Trinidad and Tobago). In a few countries there is some evidence that the youngest one or two cohorts are signaling a period of transition to later mean ages at marriage and birth and to more heterogeneity in ages at marriage and first birth. But that evidence must be viewed with caution, since considerable extrapolation is needed to obtain results.

When we examine relations among the parameters of the marriage and first-birth models, four clear associations emerge. There are strong positive correlations between

(*a*) the mean age at first birth and the mean age at marriage ($\rho = .81$);

(*b*) the standard deviation of age at first birth and the standard deviation of age at first marriage ($\rho = .72$);

(*c*) the mean age at first birth and the standard deviation of age at first birth ($\rho = .60$); and

(*d*) the mean age at first marriage and the standard deviation of age at first marriage ($\rho = .70$).

Since, in most populations surveyed by WFS, marriage (as defined by WFS) signals the beginning of regular sexual relations and since, in most of those populations, contraception is not widely practiced before the first birth, a close relation between age at marriage and age at first birth is to be expected on physiological grounds. Similarly, if marriage or first birth occurs on average at an early age, then population behaviour would tend to be more homogeneous than if those events, on average, occurred at later ages; thus the positive associations between means and standard deviations would also be expected. Nevertheless, neither the magnitude of those associations (as measured by the correlation coefficient) nor the functional form (as summarized by a linear regression) could be predicted without actually examining the data. On the other hand, we found only very weak associations between the proportions ever marrying and ever having a first birth and between the proportion ever experiencing either event and the mean age and standard deviation of age at that event. Our results have one implication for model-builders. In situations in which one wishes to capture the bulk of empirical behaviour without replicating exactly all observed differences, then one might safely reduce the number of parameters in the marriage or birth models from three to two. In such models the standard deviation would be a predetermined function of the mean; lacking more specific evidence for a particular population, the model-builder could use the linear functions presented in the section above. Any attempt to go further to produce a one-parameter model would seem to us to be hopelessly heroic, because the proportion ever experiencing the event has such a small empirical association with either of the other two parameters.

The picture we have sketched here is painted with the broadest possible brush, because we examine aggregate behaviour only at the national level. Analysis of subgroup differences can be very rewarding, and we regret that time limitations have precluded more detailed study here. The reader is referred to an excellent comparative analysis of socio-economic differentials of age at marriage by Ebanks and Singh (1984) that builds on the earlier work of McCarthy (1982). In addition, Smith and others (1984) have estimated multivariate models of the determinants of age at marriage

in Asia. Differentials in age at first birth have not been examined so thoroughly, though Trussell and Bloom (1983) have completed an illustrative multivariate analysis based on an extension of the Coale/McNeil model.

Notes

[1] If we consider the cohorts 40-49 as a group, 25 per cent are less than 17.6 years and 25 per cent are greater than 20.1 years. Hence the interquartile range is 2.5 years. In the cohorts aged 20-29, the interquartile range is 3.1 years, or 0.6 years greater. Corresponding values for the variances for the two groups are 4.0 and 5.3 years, respectively.

[2] Coale (1983), in an intensive analysis of the quality of data in the Egyptian Fertility Survey, has shown that women 10-25 years of age (especially those of less than 20) tended to overstate their ages. Since both marriages and births appear to have occurred at younger ages than they actually did occur, the bias causes a false time trend of rising age at marriage and results in a period TFR that is too low. The reason is not that either marriages or births are under-reported, but that the age schedules of first marriage and fertility rates begin too late. Note that the false time trend shows up in our analysis only as a low value of the proportion ever marrying (or having a birth) among those aged 20-24. If the proportions are fixed at more plausible levels (see annex III), we would observe a (false) increase in the mean age at marriage (or first birth) for the cohort aged 20-24.

[3] If we consider the cohorts aged 40-49, the interquartile range is 1.6 years. In the age groups 20-29, the interquartile range is 0.9 years greater, or 2.5 years (see note 1 above). Corresponding values for the variances for the two groups are 1.7 and 3.4 years, respectively.

[4] Note that a false trend towards homogeneity will be created when first births are omitted proportionately more often by women in older cohorts.

[5] Note that in those countries in which only ever-married women were given the intensive individual survey, our procedure for estimating the proportions having a first birth would produce results that are biased downwards unambiguously, since we assume that unmarried women either do not have births or marry before the survey.

[6] We do not suggest that 98 per cent of couples could actually bear children. In fact, the proportion is generally thought to be lower (94-96 per cent). We offer 98 per cent only as the greatest upper bound and doubt that anyone would seriously argue for a greater figure. Note that to bear children, both the man and the woman must be fecund.

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ANNEX I

Age at first marriage

Country	Age group	Mean age	Std. error[a]	Std. deviation	Std. error[a]	Prop. ever married[b]	Std. error[a]	Quality of fit[c]	Homog. of cohorts[d]
Africa									
Benin	20-24	19.1	.15	4.3	.12	0.99	[e]	0.00	0.03
	25-29	18.7	.15	4.4	.12	0.99	[e]	0.19	0.08
	30-34	18.9	.18	4.4	.12	1.01	0.01	0.00	0.37
	35-39	19.1	.23	4.8	.19	1.00	0.00	0.00	0.10
	40-44	19.8	.25	5.0	.20	1.00	0.00	0.03	0.60
	45-49	20.5	.30	5.4	.24	1.00	0.00	0.57	0.96
Cameroon	20-24	17.8	.11	4.3	.08	0.99	[e]	0.00	0.00
	25-29	17.8	.14	4.7	.11	0.99	[e]	0.01	0.00
	30-34	17.5	.13	4.3	.11	0.99	0.00	0.00	0.00
	35-39	18.4	.16	5.1	.14	1.00	0.00	0.00	0.00
	40-44	18.5	.17	5.2	.15	0.99	0.00	0.00	0.00
	45-49	20.0	.26	6.3	.22	0.98	0.01	0.00	0.00
Côte d'Ivoire	20-24	17.9	.14	3.5	.12	1.00	0.01	0.09	0.22
	25-29	18.3	.15	4.2	.13	1.00	0.01	0.00	0.30
	30-34	18.0	.16	4.1	.13	0.99	0.01	0.01	0.71
	35-39	18.4	.16	3.9	.13	1.00	0.00	0.01	0.13
	40-44	19.0	.20	4.9	.17	1.00	0.00	0.01	0.59
	45-49	18.7	.21	4.0	.18	1.00	0.00	0.74	0.73
Ghana	20-24	18.9	.02	4.0	.07	0.99	[e]	0.19	0.77
	25-29	19.0	.12	4.4	.09	0.99	[e]	0.81	0.01
	30-34	19.0	.18	4.7	.14	1.01	0.00	0.00	0.19
	35-39	18.8	.18	4.6	.15	1.00	0.00	0.00	0.91
	40-44	19.2	.17	4.6	.15	1.00	0.00	0.00	0.35
	45-49	19.0	.19	3.9	.14	1.00	0.00	0.98	1.00

Kenya	20-24	19.5	.14	4.9	.12	1.00	[e]	0.00	0.11
	25-29	18.8	.12	4.8	.10	1.00	[e]	0.23	0.10
	30-34	18.2	.14	4.4	.12	1.00	0.00	0.00	0.02
	35-39	18.2	.15	4.9	.13	1.00	0.00	0.00	0.00
	40-44	18.3	.18	4.3	.14	0.99	0.00	0.60	0.77
	45-49	19.1	.19	4.7	.15	1.00	0.00	0.19	0.91
Lesotho	20-24	19.1	.09	4.2	.08	1.00	[e]	0.02	0.02
	25-29	19.8	.20	4.8	.17	1.00	0.01	0.16	0.09
	30-34	19.4	.21	4.6	.17	0.97	0.01	0.64	0.27
	35-39	19.6	.22	4.8	.17	0.98	0.00	0.41	0.26
	40-44	19.5	.21	4.6	.17	0.98	0.00	0.16	0.92
	45-49	18.9	.27	4.5	.20	0.97	0.00	0.12	1.00
Nigeria	20-24	17.5	.25	4.8	.21	1.00	0.02	0.02	0.02
	25-29	17.1	.13	4.7	.11	1.01	0.01	0.02	0.02
	30-34	16.8	.15	4.5	.11	1.00	0.00	0.02	0.02
	35-39	17.1	.14	4.5	.12	1.00	0.00	0.02	0.00
	40-44	18.4	.17	5.2	.14	0.99	0.00	0.00	0.26
	45-49	18.3	.21	5.1	.18	0.99	0.00	0.00	0.18
Senegal	20-24	17.3	.18	3.5	.16	0.95	0.02	0.08	0.26
	25-29	17.3	.16	3.7	.14	0.99	0.01	0.00	0.02
	30-34	16.4	.09	2.7	.07	0.99	0.01	0.04	0.73
	35-39	16.6	.06	2.8	.06	0.98	0.04	0.00	0.94
	40-44	16.4	.14	2.8	.12	1.00	0.00	0.99	1.00
	45-49	17.0	.18	2.9	.15	1.00	0.00	1.00	1.00
Egypt	20-24	19.7	.23	5.1	.19	0.87	0.02	0.02	0.43
	25-29	19.8	.18	5.4	.16	0.96	0.01	0.03	0.09
	30-34	18.5	.13	4.6	.12	0.98	0.01	0.01	0.03
	35-39	17.7	.12	4.3	.11	0.98	0.00	0.01	0.18
	40-44	17.6	.13	4.3	.11	0.98	0.00	0.09	0.55
	45-49	17.6	.14	4.3	.12	0.99	0.00	0.13	0.78
Mauritania	20-24	16.8	.29	5.4	.24	0.90	0.02	0.00	0.16
	25-29	16.3	.26	5.1	.23	0.95	0.01	0.01	0.58
	30-34	15.6	.21	4.6	.19	0.96	0.01	0.00	0.00
	35-39	15.6	.23	4.8	.20	0.98	0.00	0.03	0.20
	40-44	15.9	.27	5.0	.23	0.98	0.00	0.02	0.28
	45-49	17.1	.36	5.7	.32	0.99	0.00	0.02	0.38

Country	Age group	Mean age	Std. error[a]	Std. deviation	Std. error[a]	Prop. ever married[b]	Std. error[a]	Quality of fit[c]	Homog. of cohorts[d]
Africa (cont.)									
Morocco	20-24	20.6	.41	5.9	.31	0.95	0.05	0.00	0.00
	25-29	19.2	.25	5.3	.21	0.96	0.02	0.05	0.12
	30-34	17.7	.20	4.5	.16	0.99	0.01	0.10	0.51
	35-39	16.6	.16	4.1	.13	0.99	0.00	0.20	0.58
	40-44	16.9	.17	4.2	.14	1.00	0.00	0.60	0.99
	45-49	16.3	.17	3.7	.14	1.00	0.00	1.00	1.00
Sudan (North)	20-24	18.8	.49	6.3	.40	0.85	0.03	0.09	0.39
	25-29	17.5	.22	4.8	.19	0.94	0.01	0.59	0.91
	30-34	16.6	.21	4.5	.17	0.97	0.01	0.28	0.64
	35-39	17.3	.22	5.2	.19	0.99	0.00	0.27	0.23
	40-44	16.7	.28	4.8	.24	0.99	0.00	0.69	0.88
	45-49	17.4	.33	5.0	.28	0.99	0.00	0.64	0.92
Tunisia	20-24	22.7	.50	5.3	.36	0.79	0.06	0.00	0.08
	25-29	22.2	.32	5.8	.26	0.96	0.02	0.00	0.02
	30-34	20.2	.23	5.1	.19	0.97	0.01	0.04	0.36
	35-39	19.8	.21	5.3	.19	0.99	0.01	0.00	0.54
	40-44	19.7	.21	5.3	.18	0.99	0.01	0.00	0.70
	45-49	20.1	.26	5.7	.22	0.99	0.01	0.04	0.56
Asia and the Pacific									
Jordan	20-24	19.2	.27	4.5	.23	0.81	0.02	0.01	0.26
	25-29	18.9	.21	4.7	.18	0.93	0.01	0.00	0.00
	30-34	18.5	.20	4.7	.17	0.97	0.01	0.15	0.24
	35-39	18.0	.19	4.3	.15	0.98	0.00	0.11	0.30
	40-44	17.7	.21	4.4	.18	0.98	0.00	0.16	0.42
	45-49	17.2	.22	4.0	.19	0.98	0.00	0.26	0.61
Syrian Arab Republic	20-24	20.3	.35	5.4	.28	0.85	0.03	0.31	0.70
	25-29	19.9	.25	5.4	.21	0.91	0.01	0.64	0.51
	30-34	19.2	.21	5.0	.18	0.95	0.01	0.00	0.07
	35-39	19.9	.23	5.3	.19	0.96	0.01	0.01	0.39
	40-44	20.0	.24	5.5	.20	0.97	0.00	0.03	0.21
	45-49	19.7	.25	5.6	.21	0.98	0.00	0.13	0.28

Turkey	20-24	20.0	.16	5.1	.13	0.99	e	0.00	0.17
	25-29	19.2	.18	4.3	.15	0.98	0.01	0.18	0.62
	30-34	18.4	.16	4.1	.14	0.98	0.01	0.02	0.06
	35-39	17.7	.15	3.8	.12	0.99	0.00	0.03	0.25
	40-44	18.2	.16	4.1	.12	0.99	0.01	0.06	0.66
	45-49	18.3	.18	4.1	.15	0.99	0.00	0.04	0.57
Yemen	20-24	15.9	.12	3.9	.09	0.99	e	0.63	0.58
	25-29	16.2	.15	4.4	.11	0.99	e	0.00	0.01
	30-34	16.3	.23	4.5	.21	0.99	0.00	0.17	0.89
	35-39	16.8	.27	4.8	.23	0.99	0.00	0.39	0.91
	40-44	16.2	.34	4.8	.30	0.99	0.00	0.52	0.86
	45-49	17.1	.44	5.6	.39	0.99	0.00	0.74	0.96
Bangladesh	20-24	13.9	.10	3.2	.09	0.98	0.01	0.04	0.04
	25-29	13.3	.09	2.9	.07	0.99	0.00	0.06	0.03
	30-34	12.8	.10	2.7	.08	1.00	0.00	0.76	0.62
	35-39	13.1	.12	3.1	.10	1.00	0.00	0.10	0.41
	40-44	13.0	.11	2.8	.09	1.00	0.00	0.29	1.00
	45-49	12.9	.14	2.9	.12	1.00	e	0.44	1.00
Nepal	20-24	16.6	.12	4.5	.10	1.00	e	0.25	0.24
	25-29	16.4	.14	4.6	.11	1.00	e	0.01	0.46
	30-34	16.2	.16	4.5	.14	1.00	0.00	0.00	0.28
	35-39	17.0	.18	4.9	.15	1.00	0.00	0.32	0.96
	40-44	16.8	.19	4.9	.15	1.00	0.00	0.00	0.03
	45-49	17.0	.23	5.3	.19	0.99	0.00	0.00	0.86
Pakistan	20-24	17.5	.19	4.0	.16	0.91	0.02	0.01	0.34
	25-29	17.7	.16	4.3	.14	0.96	0.01	0.01	0.40
	30-34	17.1	.14	3.8	.13	0.97	0.01	0.32	0.58
	35-39	16.7	.16	4.1	.13	0.98	0.01	0.01	0.27
	40-44	16.0	.13	3.3	.12	0.99	0.00	0.03	0.26
	45-49	16.4	.15	3.5	.12	0.99	0.00	0.25	0.89
Sri Lanka	20-24	24.8	.81	8.0	.56	0.88	0.08	0.10	0.12
	25-29	24.9	.53	9.1	.41	1.00	0.04	0.00	0.01
	30-34	21.6	.26	7.0	.22	0.94	0.01	0.00	0.02
	35-39	20.8	.21	6 .6	.18	0.97	0.01	0.00	0.00
	40-44	20.1	.21	6.0	.17	0.96	0.01	0.00	0.00
	45-49	19.8	.18	5.7	.15	0.98	0.00	0.00	0.00

Country	Age group	Mean age	Std. error[a]	Std. deviation	Std. error[a]	Prop. ever married[b]	Std. error[a]	Quality of fit[c]	Homog. of cohorts[d]
Asia and the Pacific (cont.)									
Fiji	20-24	21.4	.15	5.0	.12	0.99	[e]	0.35	0.26
	25-29	20.4	.13	5.3	.09	0.99	[e]	0.00	0.91
	30-34	19.3	.20	5.0	.17	0.99	0.01	0.00	0.02
	35-39	19.0	.19	5.1	.16	0.98	0.01	0.00	0.10
	40-44	18.6	.20	4.9	.17	0.98	0.01	0.09	0.48
	45-49	18.6	.23	4.9	.19	0.99	0.01	0.98	0.98
Indonesia	20-24	18.4	.12	5.4	.10	0.99	[e]	0.00	0.00
	25-29	17.2	.15	5.0	.13	1.00	0.01	0.00	0.02
	30-34	16.5	.13	4.6	.11	0.99	0.00	0.00	0.02
	35-39	16.2	.13	4.6	.11	0.99	0.00	0.00	0.04
	40-44	16.0	.13	4.4	.11	0.99	0.00	0.00	0.04
	45-49	16.2	.14	4.4	.12	0.99	0.00	0.02	0.38
Malaysia	20-24	23.1	.18	6.5	.17	0.99	[e]	0.25	0.21
	25-29	22.0	.19	6.6	.15	0.99	[e]	0.23	0.59
	30-34	20.5	.22	6.1	.19	0.98	0.01	0.00	0.01
	35-39	19.0	.17	5.3	.14	0.97	0.01	0.12	0.48
	40-44	18.6	.18	5.2	.15	0.99	0.01	0.00	0.04
	45-49	17.8	.18	4.9	.14	0.99	0.00	0.25	0.75
Philippines	20-24	22.0	.35	5.5	.26	0.67	0.03	0.00	0.00
	25-29	21.8	.19	5.2	.16	0.82	0.01	0.00	0.12
	30-34	21.8	.17	5.7	.14	0.91	0.01	0.00	0.01
	35-39	21.3	.15	5.4	.12	0.93	0.01	0.00	0.00
	40-44	21.0	.15	5.2	.12	0.95	0.01	0.00	0.00
	45-49	21.3	.16	5.5	.13	0.95	0.01	0.00	0.03
Republic of Korea	20-24	23.7	.09	4.3	.10	1.00	[e]	0.00	0.53
	25-29	22.8	.08	3.8	.06	1.00	[e]	0.00	0.00
	30-34	22.4	.09	4.1	.08	1.01	0.00	0.31	0.14
	35-39	20.7	.10	3.4	.09	1.00	0.00	0.00	0.05
	40-44	19.0	.12	3.3	.10	1.00	0.00	0.00	0.03
	45-49	17.6	.10	2.5	.08	1.00	0.00	0.04	0.78

Thailand	20-24	21.5	.03	5.2	.11	0.91	0.02	0.25	0.58
	25-29	21.2	.26	5.2	.22	0.92	0.02	0.00	0.02
	30-34	20.8	.23	5.0	.20	0.93	0.01	0.00	0.48
	35-39	20.8	.22	5.2	.18	0.95	0.01	0.00	0.00
	40-44	20.2	.19	4.4	.15	0.96	0.01	0.06	0.67
	45-49	20.3	.20	4.3	.17	0.97	0.01	0.49	0.89
Americas									
Colombia	20-24	21.6	.55	6.0	.42	0.89	0.06	0.17	0.39
	25-29	21.3	.35	6.0	.29	0.91	0.02	0.38	0.30
	30-34	20.6	.25	5.0	.21	0.92	0.02	0.06	0.24
	35-39	20.4	.25	5.4	.23	0.89	0.01	0.23	0.35
	40-44	21.2	.28	5.8	.24	0.92	0.01	0.93	0.93
	45-49	21.7	.32	6.4	.27	0.91	0.01	0.55	0.65
Ecuador	20-24	20.9	.38	5.3	.30	0.86	0.04	0.07	0.09
	25-29	21.2	.28	5.6	.24	0.92	0.02	0.28	0.45
	30-34	20.4	.20	5.2	.17	0.93	0.01	0.07	0.06
	35-39	20.0	.21	5.1	.19	0.93	0.01	0.69	0.79
	40-44	19.9	.23	5.2	.20	0.92	0.01	0.86	0.97
	45-49	20.6	.28	5.6	.23	0.94	0.01	0.86	0.89
Paraguay	20-24	21.1	.44	5.0	.35	0.84	0.05	0.54	0.54
	25-29	21.4	.31	5.3	.26	0.94	0.03	0.24	0.18
	30-34	21.7	.32	5.9	.28	0.95	0.02	0.38	0.49
	35-39	21.1	.27	5.3	.23	0.95	0.01	0.10	0.12
	40-44	20.6	.27	5.0	.23	0.95	0.01	0.12	0.25
	45-49	21.2	.28	5.2	.24	0.95	0.01	1.00	1.00
Peru	20-24	23.2	.48	6.7	.35	0.98	0.05	0.07	0.89
	25-29	21.4	.26	5.7	.22	0.90	0.02	0.25	0.15
	30-34	20.9	.22	5.4	.19	0.93	0.01	0.00	0.22
	35-39	20.4	.18	5.1	.16	0.93	0.01	0.00	0.00
	40-44	20.6	.18	5.1	.15	0.95	0.00	0.00	0.75
	45-49	20.9	.20	5.4	.17	0.95	0.00	0.15	0.36
Venezuela	20-24	21.5	.49	5.7	.37	0.93	0.06	0.18	0.29
	25-29	20.8	.31	5.6	.26	0.93	0.02	0.02	0.09
	30-34	20.3	.30	5.6	.26	0.96	0.01	0.01	0.03
	35-39	19.9	.27	5.2	.23	0.97	0.01	0.30	0.45
	40-44	20.1	.28	5.2	.23	0.97	0.01	0.88	0.78

Country	Age group	Mean age	Std. error[a]	Std. deviation	Std. error[a]	Prop. ever married[b]	Std. error[a]	Quality of fit[c]	Homog. of cohorts[d]
Americas (cont.)									
Costa Rica	20-24	21.6	.50	5.3	.38	0.87	0.06	0.22	0.15
	25-29	22.2	.36	5.8	.30	0.90	0.03	0.36	0.69
	30-34	21.8	.28	5.6	.24	0.93	0.02	0.78	0.65
	35-39	21.4	.28	5.7	.24	0.88	0.02	0.88	0.91
	40-44	21.5	.27	5.2	.23	0.90	0.02	0.42	0.28
	45-49	22.4	.30	5.6	.25	0.91	0.01	0.29	0.33
Dominican Republic	20-24	19.6	.43	4.9	.35	0.97	0.05	0.47	0.32
	25-29	18.7	.26	4.7	.22	0.97	0.02	0.53	0.96
	30-34	19.1	.30	4.9	.25	0.98	0.01	0.00	0.03
	35-39	18.6	.24	4.4	.20	0.99	0.01	0.98	0.98
	40-44	18.7	.31	4.9	.26	0.98	0.01	0.91	0.97
	45-49	19.3	.31	4.8	.25	0.97	0.01	1.00	1.00
Mexico	20-24	20.9	.15	5.6	.13	0.96	[e]	0.01	0.13
	25-29	20.6	.22	5.6	.18	0.96	0.02	0.02	0.31
	30-34	20.0	.18	5.1	.15	0.94	0.01	0.01	0.03
	35-39	19.8	.17	5.1	.14	0.95	0.01	0.13	0.08
	40-44	19.7	.19	5.1	.15	0.94	0.01	0.53	0.77
	45-49	20.0	.20	5.4	.17	0.96	0.01	0.80	0.94
Panama	20-24	21.4	.36	5.6	.37	0.96	[e]	0.04	0.15
	25-29	21.0	.29	5.5	.25	1.00	0.02	0.20	0.46
	30-34	20.1	.22	4.8	.19	0.95	0.01	0.01	0.03
	35-39	20.0	.23	5.0	.20	0.96	0.01	0.90	0.84
	40-44	19.9	.26	5.0	.23	0.97	0.01	0.79	0.87
	45-49	19.8	.28	5.3	.25	0.98	0.01	0.98	0.97
Guyana	20-24	19.9	.28	4.8	.21	1.01	0.03	0.01	0.35
	25-29	19.2	.20	4.2	.16	0.98	0.01	0.08	0.37
	30-34	18.6	.19	4.2	.15	0.99	0.01	0.00	0.58
	35-39	18.6	.20	4.4	.16	0.97	0.01	0.20	0.96
	40-44	18.5	.20	4.0	.16	0.98	0.01	0.91	0.99
	45-49	18.8	.21	4.5	.18	0.98	0.01	0.66	0.71

Haiti	20-24	21.2	.59	5.8	.45	0.93	0.07	0.01	0.02
	25-29	20.6	.26	5.5	.22	0.95	[e]	0.96	0.99
	30-34	20.6	.29	5.5	.25	0.95	[e]	0.01	0.03
	35-39	21.0	.31	6.2	.24	0.99	0.01	0.60	0.54
	40-44	20.1	.31	4.9	.26	0.98	0.01	0.97	0.98
	45-49	21.9	.34	5.5	.28	0.98	0.01	1.00	1.00
Jamaica	20-24	18.2	.20	3.6	.16	1.00	0.02	0.01	0.22
	25-29	18.7	.07	4.5	.09	0.99	[e]	0.01	0.13
	30-34	18.6	.19	3.8	.17	0.99	0.01	0.02	0.40
	35-39	19.4	.24	4.5	.20	0.98	0.01	0.20	0.48
	40-44	20.4	.28	5.1	.23	0.99	0.01	0.02	0.20
	45-49	20.9	.27	5.2	.23	0.99	0.01	0.41	0.55
Trinidad and Tobago	20-24	19.7	.30	4.5	.25	0.91	0.04	0.04	0.04
	25-29	20.2	.24	5.1	.21	1.01	0.02	0.05	0.27
	30-34	19.9	.24	5.3	.20	0.98	0.01	0.46	0.73
	35-39	19.2	.21	4.6	.17	0.97	0.01	0.18	0.15
	40-44	18.6	.21	4.3	.18	0.98	0.01	0.85	0.96
	45-49	18.7	.23	4.6	.19	0.98	0.01	1.00	1.00
Europe									
Portugal	20-24	23.9	.13	5.6	.10	0.95	[e]	0.04	0.04
	25-29	24.2	.08	5.8	.04	0.95	[e]	0.00	0.00
	30-34	23.7	.08	5.3	.06	0.95	0.01	0.58	0.58
	35-39	23.7	.07	5.1	.06	0.94	0.01	0.21	0.21
	40-44	23.9	.06	5.1	.05	0.92	0.01	0.74	0.74
	45-49	24.1	.06	5.5	.05	0.93	0.01	0.69	0.69

[a] Of the estimates.

[b] Proportion ever marrying by age 50.

[c] *P* value for overall quality of fit of the data to the model, equalling 1.00 if the fit is perfect and 0.00 if the fit is poor.

[d] How similar the cohorts are in following the same nuptiality schedule, equalling 1.00 if they follow the same curve and 0.00 if they do not follow the same nuptiality schedule.

[e] When the estimated proportion ever marrying was greater than 1.01, its value was fixed at a more plausible level and the model was run again. In such cases, where the proportion ever marrying was fixed, there is no standard error.

ANNEX II

Age at first birth

Country	Age group	Mean age	Std. error[a]	Std. deviation	Std. error[a]	Prop. ever having birth[b]	Std. error[a]	Quality of fit[c]	Homog. of cohorts[d]
Africa									
Benin	20-24	21.0	.16	4.7	.14	1.00	[e]	0.40	0.17
	25-29	20.5	.08	4.8	.08	1.00	[e]	0.00	0.31
	30-34	20.4	.24	5.3	.20	1.00	0.01	0.07	0.88
	35-39	20.4	.27	5.4	.22	0.98	0.01	0.00	0.08
	40-44	21.1	.29	5.5	.24	0.98	0.01	0.00	0.39
	45-49	21.6	.30	5.0	.24	0.96	0.01	0.75	0.96
Cameroon	20-24	19.6	.11	4.0	.09	0.97	[e]	0.74	0.05
	25-29	20.1	.16	4.5	.14	0.97	0.01	0.00	0.00
	30-34	19.9	.18	5.1	.15	0.93	0.01	0.00	0.00
	35-39	20.6	.19	5.2	.16	0.90	0.01	0.00	0.00
	40-44	20.7	.20	5.3	.17	0.90	0.01	0.00	0.07
	45-49	22.0	.25	6.0	.21	0.85	0.01	0.00	0.00
Côte d'Ivoire	20-24	19.0	.11	3.7	.09	0.99	[e]	0.00	0.06
	25-29	19.4	.15	3.9	.13	0.99	0.01	0.00	0.20
	30-34	19.2	.15	3.9	.13	0.96	0.01	0.01	0.47
	35-39	19.9	.17	4.1	.14	0.97	0.01	0.53	0.61
	40-44	20.1	.19	4.2	.16	0.97	0.01	0.47	0.34
	45-49	20.4	.24	4.3	.20	0.95	0.01	1.00	1.00
Ghana	20-24	20.4	.13	4.2	.11	0.99	[e]	0.01	0.87
	25-29	20.7	.14	4.6	.12	0.99	[e]	0.00	0.22
	30-34	20.6	.20	5.0	.17	0.99	0.01	0.00	0.06
	35-39	20.5	.20	5.0	.17	0.99	0.01	0.26	0.50
	40-44	21.2	.21	5.0	.18	0.98	0.01	0.94	0.90
	45-49	21.2	.24	5.1	.20	0.98	0.01	0.99	0.98

Kenya.....	20-24	19.9	.12	4.5	.10	0.99	[c]	0.28	0.13
	25-29	19.6	.11	4.5	.09	0.99	[c]	0.06	0.25
	30-34	19.2	.14	4.5	.08	0.99	0.01	0.00	0.00
	35-39	19.7	.17	5.0	.14	0.99	0.01	0.00	0.00
	40-44	20.0	.19	4.6	.16	0.97	0.01	0.49	0.84
	45-49	21.3	.21	5.4	.17	0.98	0.01	0.12	0.34
Lesotho	20-24	20.9	.09	4.6	.09	0.95	[c]	0.20	0.35
	25-29	21.2	.13	4.6	.06	0.95	[c]	0.31	0.23
	30-34	21.4	.25	5.1	.20	0.95	0.01	0.48	0.18
	35-39	21.6	.21	4.6	.17	0.94	0.01	0.00	0.56
	40-44	21.9	.23	5.0	.20	0.93	0.01	0.17	0.75
	45-49	21.5	.30	5.0	.24	0.94	0.01	0.02	0.93
Nigeria	20-24	20.0	.28	5.1	.23	1.00	0.03	1.00	1.00
	25-29	20.2	.13	5.2	.11	0.99	[c]	0.02	0.09
	30-34	20.2	.16	5.2	.14	0.99	0.01	0.00	0.01
	35-39	20.9	.18	5.3	.16	0.95	0.01	0.00	0.00
	40-44	22.5	.22	6.4	.18	0.94	0.01	0.00	0.00
	45-49	22.9	.28	6.4	.24	0.92	0.01	0.00	0.00
Senegal.....	20-24	19.4	.22	3.6	.18	0.97	0.03	0.29	0.41
	25-29	19.4	.18	3.9	.15	0.98	0.01	0.20	0.62
	30-34	18.3	.14	3.0	.12	0.96	0.01	0.10	0.55
	35-39	18.5	.14	3.1	.11	0.96	0.01	0.21	0.56
	40-44	18.7	.17	3.3	.14	0.96	0.01	0.95	0.99
	45-49	19.4	.21	3.4	.18	0.97	0.01	1.00	1.00
Egypt	20-24	21.7	.33	5.1	.25	0.86	0.04	0.43	0.83
	25-29	22.2	.24	6.0	.20	0.96	0.02	0.90	0.87
	30-34	20.5	.16	4.8	.13	0.96	0.01	0.00	0.00
	35-39	20.0	.14	4.5	.11	0.95	0.01	0.30	0.62
	40-44	20.0	.14	4.6	.12	0.94	0.01	0.16	0.41
	45-49	19.9	.15	4.4	.13	0.95	0.01	0.87	0.89
Mauritania	20-24	20.8	.46	6.6	.38	1.00	0.04	0.00	0.06
	25-29	19.6	.29	5.6	.25	0.95	0.01	0.04	0.28
	30-34	18.8	.26	5.3	.22	0.94	0.01	0.00	0.01
	35-39	20.0	.35	6.6	.30	0.97	0.01	0.01	0.06
	40-44	20.7	.45	7.3	.39	0.93	0.01	0.04	0.23
	45-49	21.1	.48	7.1	.41	0.96	0.01	0.00	0.09

Country	Age group	Mean age	Std. error[a]	Std. deviation	Std. error[a]	Prop. ever having birth[b]	Std. error[a]	Quality of fit[c]	Homog. of cohorts[d]
Africa (cont.)									
Morocco	20-24	22.5	.23	5.8	.20	0.92	[e]	0.02	0.04
	25-29	21.4	.29	5.5	.25	0.92	0.02	0.34	0.60
	30-34	20.4	.23	4.9	.20	0.95	0.01	0.13	0.10
	35-39	19.5	.19	4.7	.16	0.94	0.01	0.02	0.03
	40-44	19.9	.21	4.9	.18	0.94	0.01	0.64	0.77
	45-49	19.5	.22	4.4	.18	0.92	0.01	1.00	1.00
Sudan (North)	20-24	20.7	.57	6.2	.45	0.83	0.05	0.51	0.64
	25-29	20.1	.27	5.2	.23	0.93	0.02	0.17	0.21
	30-34	19.4	.28	5.2	.24	0.94	0.01	0.33	0.62
	35-39	20.7	.28	6.2	.25	0.95	0.01	0.11	0.28
	40-44	20.4	.37	6.1	.35	0.93	0.01	0.33	0.73
	45-49	21.8	.43	6.2	.37	0.93	0.01	0.62	0.71
Tunisia	20-24	24.8	.73	5.5	.50	0.91	0.11	0.01	0.03
	25-29	24.2	.39	6.0	.31	0.99	0.04	0.04	0.21
	30-34	22.3	.25	5.4	.22	0.95	0.01	0.00	0.08
	35-39	22.0	.23	5.3	.19	0.96	0.01	0.00	0.03
	40-44	22.1	.22	5.5	.18	0.95	0.01	0.00	0.11
	45-49	22.7	.26	5.7	.22	0.95	0.01	0.18	0.97
Asia and the Pacific									
Jordan	20-24	20.2	.28	4.0	.23	0.76	0.03	0.57	0.89
	25-29	20.5	.21	4.5	.18	0.93	0.01	0.00	0.00
	30-34	20.1	.22	4.6	.19	0.94	0.01	0.04	0.09
	35-39	20.2	.21	4.6	.17	0.96	0.00	0.04	0.38
	40-44	20.1	.26	5.0	.22	0.95	0.01	0.32	0.01
	45-49	19.7	.24	4.5	.21	0.96	0.01	0.00	0.09
Syrian Arab Republic	20-24	22.6	.47	5.8	.36	0.94	0.05	0.02	0.08
	25-29	21.8	.29	5.4	.25	0.90	0.02	0.50	0.48
	30-34	21.1	.21	4.7	.18	0.91	0.01	0.00	0.00
	35-39	22.0	.23	5.2	.20	0.94	0.01	0.04	0.17
	40-44	22.0	.24	5.3	.20	0.94	0.01	0.75	0.91
	45-49	22.0	.26	5.6	.22	0.95	0.01	0.05	0.13

Turkey	20-24	21.8	.19	5.6	.16	0.98	[c]	0.21	0.11
	25-29	20.9	.22	4.7	.20	0.97	0.02	0.16	0.28
	30-34	20.6	.22	5.2	.18	0.97	0.01	0.00	0.24
	35-39	19.9	.17	4.1	.14	0.98	0.01	0.02	0.09
	40-44	20.4	.20	4.8	.16	0.96	0.01	0.02	0.96
	45-49	20.8	.20	4.5	.16	0.97	0.01	0.02	0.65
Yemen	20-24	19.9	.10	4.5	.12	0.99	[c]	0.06	0.51
	25-29	19.9	.14	4.8	.11	0.99	[c]	0.01	0.01
	30-34	20.9	.35	6.1	.33	1.01	0.01	0.00	0.02
	35-39	21.4	.37	5.9	.32	0.99	0.01	0.09	0.16
	40-44	22.3	.52	6.9	.45	0.99	0.01	0.06	0.78
	45-49	24.1	.62	7.8	.56	0.99	0.01	0.59	0.75
Bangladesh	20-24	17.5	.13	3.5	.11	0.97	0.01	0.09	0.63
	25-29	17.1	.10	3.0	.08	0.97	0.01	0.00	0.08
	30-34	17.1	.12	3.3	.10	0.98	0.01	0.02	0.28
	35-39	17.4	.13	3.5	.11	0.98	0.01	0.59	0.89
	40-44	17.9	.14	3.6	.12	0.97	0.01	0.00	0.05
	45-49	18.1	.18	4.0	.15	0.97	0.01	0.43	0.47
Nepal	20-24	21.0	.13	4.5	.11	0.98	[c]	0.01	0.01
	25-29	20.8	.18	4.3	.15	0.99	0.01	0.02	0.07
	30-34	20.8	.17	4.4	.15	0.96	0.01	0.32	0.25
	35-39	21.5	.19	4.8	.16	0.98	0.01	0.07	0.25
	40-44	21.7	.19	5.1	.16	0.96	0.01	0.02	0.11
	45-49	22.0	.21	4.7	.18	0.95	0.01	0.65	0.68
Pakistan	20-24	20.1	.31	4.4	.25	0.86	0.03	0.14	0.22
	25-29	20.6	.23	4.6	.20	0.93	0.02	0.08	0.50
	30-34	19.9	.16	4.0	.14	0.94	0.01	0.37	0.17
	35-39	19.8	.17	4.0	.14	0.93	0.01	0.01	0.09
	40-44	19.1	.16	3.9	.14	0.95	0.01	0.35	0.92
	45-49	19.4	.17	3.8	.15	0.96	0.01	0.29	0.33
Sri Lanka	20-24	25.8	.94	7.5	.63	0.84	0.10	0.66	0.81
	25-29	25.6	.53	8.3	.41	0.92	0.04	0.37	0.43
	30-34	22.9	.28	6.6	.25	0.90	0.01	0.02	0.04
	35-39	22.8	.24	7.0	.21	0.95	0.01	0.02	0.02
	40-44	21.6	.20	5.9	.17	0.92	0.01	0.00	0.00
	45-49	21.6	.18	5.7	.15	0.95	0.01	0.00	0.01

Country	Age group	Mean age	Std. error[a]	Std. deviation	Std. error[a]	Prop. ever having birth[b]	Std. error[a]	Quality of fit[c]	Homog. of cohorts[d]
Asia and the Pacific (cont.)									
Fiji	20-24	23.2	.16	5.3	.15	0.99	[e]	0.00	0.75
	25-29	22.4	.19	5.6	.15	0.99	0.02	0.00	0.14
	30-34	20.9	.18	4.9	.15	0.95	0.01	0.00	0.38
	35-39	20.6	.19	4.9	.16	0.93	0.01	0.00	0.28
	40-44	20.4	.21	5.1	.17	0.94	0.01	0.08	0.76
	45-49	20.7	.26	5.4	.20	0.93	0.01	0.23	0.75
Indonesia	20-24	21.0	.10	5.5	.08	0.98	[e]	0.00	0.00
	25-29	20.5	.20	5.5	.17	0.99	0.01	0.00	0.00
	30-34	19.8	.16	5.2	.13	0.95	0.01	0.03	0.01
	35-39	19.6	.15	5.0	.12	0.93	0.01	0.00	0.00
	40-44	20.1	.15	5.2	.12	0.95	0.01	0.00	0.00
	45-49	20.7	.18	5.4	.15	0.91	0.01	0.00	0.00
Malaysia	20-24	24.1	.59	5.9	.41	0.96	0.08	0.28	0.21
	25-29	23.5	.34	6.4	.27	0.97	0.03	0.02	0.12
	30-34	22.0	.21	5.4	.17	0.96	0.01	0.37	0.77
	35-39	20.9	.15	4.9	.14	0.96	0.01	0.35	0.60
	40-44	20.8	.18	5.1	.14	0.96	0.01	0.00	0.59
	45-49	20.4	.19	5.1	.16	0.96	0.01	0.05	0.67
Philippines	20-24	23.4	.43	5.4	.31	0.75	0.05	0.33	0.28
	25-29	23.1	.21	5.1	.17	0.82	0.02	0.00	0.02
	30-34	23.1	.17	5.5	.14	0.90	0.01	0.00	0.03
	35-39	22.5	.14	5.3	.12	0.91	0.01	0.00	0.05
	40-44	22.4	.14	5.2	.12	0.93	0.01	0.00	0.00
	45-49	23.0	.15	5.4	.13	0.92	0.01	0.00	0.01
Republic of Korea	20-24	25.1	.12	4.6	.14	0.98	[e]	0.01	0.34
	25-29	24.1	.07	3.8	.06	0.98	[e]	0.06	0.09
	30-34	24.2	.14	4.1	.11	1.00	0.01	0.00	0.38
	35-39	22.7	.11	3.3	.09	0.98	0.00	0.00	0.07
	40-44	21.8	.12	3.6	.10	0.98	0.00	0.01	0.03
	45-49	20.7	.12	3.1	.10	0.98	0.00	0.45	1.00

Thailand	20-24	22.9	.55	5.2	.40	0.89	0.07	0.32	0.77
	25-29	23.0	.32	5.4	.27	0.92	0.03	0.01	0.43
	30-34	22.2	.24	4.8	.21	0.91	0.01	0.01	0.08
	35-39	22.7	.21	4.9	.18	0.94	0.01	0.01	0.12
	40-44	22.4	.21	4.7	.18	0.94	0.01	0.08	0.17
	45-49	22.4	.21	4.4	.17	0.94	0.01	0.06	0.35
Americas									
Colombia	20-24	22.6	.22	5.8	.20	0.93	[e]	0.00	0.04
	25-29	22.4	.37	6.0	.32	0.93	0.03	0.00	0.00
	30-34	21.6	.25	5.0	.21	0.94	0.02	0.18	0.22
	35-39	21.7	.25	5.6	.21	0.90	0.01	0.02	0.01
	40-44	22.0	.27	5.6	.22	0.91	0.01	0.36	0.64
	45-49	22.5	.31	6.2	.26	0.92	0.01	0.66	0.96
Ecuador	20-24	22.7	.47	5.7	.35	0.99	0.06	0.09	0.22
	25-29	22.4	.30	5.6	.25	0.95	0.02	0.35	0.43
	30-34	21.5	.22	5.2	.19	0.93	0.01	0.16	0.23
	35-39	21.3	.22	5.2	.18	0.94	0.01	0.08	0.35
	40-44	21.3	.24	5.4	.20	0.94	0.01	0.18	0.46
	45-49	22.4	.26	5.7	.22	0.95	0.01	0.37	0.85
Paraguay	20-24	23.1	.62	5.5	.45	0.95	0.08	0.07	0.64
	25-29	22.5	.19	5.5	.07	0.94	0.02	0.04	0.34
	30-34	22.3	.30	5.4	.26	0.90	0.02	0.59	0.71
	35-39	22.4	.27	5.5	.24	0.94	0.01	0.17	0.23
	40-44	21.4	.24	4.6	.20	0.94	0.01	0.48	0.65
	45-49	22.0	.25	4.7	.21	0.95	0.01	0.95	0.85
Peru	20-24	22.8	.10	5.7	.12	0.86	[e]	0.07	0.44
	25-29	22.1	.26	5.3	.23	0.86	0.02	0.00	0.75
	30-34	22.0	.22	5.4	.19	0.93	0.01	0.00	0.04
	35-39	21.4	.18	5.1	.16	0.92	0.01	0.01	0.12
	40-44	21.5	.19	5.1	.16	0.94	0.00	0.33	0.13
	45-49	21.9	.20	5.4	.16	0.93	0.01	0.01	0.12
Venezuela	20-24	22.4	.56	5.5	.41	0.90	0.07	0.04	0.04
	25-29	22.2	.35	5.7	.29	0.93	0.03	0.85	0.86
	30-34	21.8	.34	5.7	.29	0.95	0.02	0.20	0.15
	35-39	21.3	.28	5.3	.24	0.95	0.01	0.61	0.71
	40-44	21.4	.28	5.0	.24	0.95	0.01	0.72	0.56

Country	Age group	Mean age	Std. error[a]	Std. deviation	Std. error[a]	Prop. ever having birth[b]	Std. error[a]	Quality of fit[c]	Homog. of cohorts[d]
Americas (cont.)									
Costa Rica	20-24	22.4	.53	5.0	.40	0.92	0.07	0.01	0.12
	25-29	22.9	.37	5.5	.30	0.94	0.03	0.48	0.58
	30-34	21.9	.22	4.8	.20	0.92	0.01	0.94	0.85
	35-39	21.7	.23	4.9	.19	0.89	0.01	0.97	0.94
	40-44	21.9	.23	4.5	.19	0.92	0.01	0.86	0.73
	45-49	22.8	.25	4.9	.21	0.92	0.01	0.80	0.88
Dominican Republic	20-24	21.2	.52	4.8	.41	0.91	0.07	0.24	0.25
	25-29	20.3	.30	4.7	.25	0.93	0.02	0.90	1.00
	30-34	20.7	.30	4.9	.24	0.96	0.02	0.01	0.05
	35-39	20.2	.25	4.5	.21	0.96	0.01	0.84	0.98
	40-44	20.3	.34	5.0	.28	0.92	0.02	0.67	0.95
	45-49	21.3	.35	5.2	.29	0.94	0.02	0.96	0.99
Mexico	20-24	21.8	.15	5.1	.13	0.94	[e]	0.02	0.07
	25-29	21.8	.23	5.4	.19	0.94	0.02	0.01	0.14
	30-34	21.3	.19	5.0	.16	0.94	0.01	0.05	0.07
	35-39	21.2	.17	5.0	.14	0.95	0.01	0.12	0.48
	40-44	21.1	.18	5.0	.15	0.93	0.01	0.34	0.62
	45-49	21.5	.21	5.3	.18	0.92	0.01	0.77	0.78
Panama	20-24	22.7	.06	5.6	.07	0.99	[e]	0.18	0.11
	25-29	22.1	.33	5.5	.28	0.99	0.03	0.17	0.18
	30-34	21.2	.21	4.7	.19	0.94	0.01	0.35	0.18
	35-39	21.2	.23	4.9	.20	0.96	0.01	0.44	0.27
	40-44	21.1	.25	4.9	.22	0.96	0.01	0.16	0.40
	45-49	21.2	.27	5.3	.24	0.95	0.01	0.94	0.87
Guyana	20-24	21.6	.40	4.6	.31	0.91	0.06	0.23	0.28
	25-29	21.1	.24	4.6	.21	0.92	0.02	0.55	0.56
	30-34	20.4	.21	4.4	.17	0.97	0.01	0.14	0.49
	35-39	20.4	.22	4.7	.18	0.94	0.01	0.13	0.44
	40-44	20.1	.22	4.2	.18	0.91	0.01	0.35	0.49
	45-49	20.7	.23	4.6	.20	0.94	0.01	0.95	0.98

Haiti	20-24	24.9	.35	7.0	.33	0.99	[e]	0.09	0.18
	25-29	23.8	.59	6.6	.47	0.99	0.05	0.78	0.57
	30-34	23.5	.34	6.5	.29	0.99	[e]	0.10	0.28
	35-39	23.4	.41	6.6	.36	0.96	0.01	0.42	0.69
	40-44	22.0	.32	5.0	.27	0.94	0.02	1.00	1.00
	45-49	24.1	.37	5.9	.31	0.96	0.01	0.76	0.79
Jamaica	20-24	19.5	.26	3.6	.21	0.89	0.03	0.56	0.52
	25-29	20.5	.32	5.2	.26	1.00	0.02	0.24	0.75
	30-34	19.8	.24	4.3	.20	0.96	0.01	0.01	0.30
	35-39	20.3	.24	4.5	.20	0.94	0.01	0.31	0.75
	40-44	21.5	.31	5.5	.26	0.94	0.01	0.15	0.38
	45-49	21.7	.30	5.3	.25	0.90	0.02	1.00	1.00
Trinidad and Tobago	20-24	22.6	.61	5.4	.45	0.81	0.07	0.13	0.74
	25-29	23.1	.43	6.1	.36	0.93	0.04	0.51	0.94
	30-34	22.3	.33	6.1	.28	0.93	0.02	0.09	0.16
	35-39	21.6	.26	5.1	.22	0.93	0.01	0.52	0.73
	40-44	20.7	.25	4.8	.21	0.93	0.01	0.77	0.83
	45-49	20.8	.27	5.1	.23	0.92	0.01	0.97	0.97
Europe									
Portugal	20-24	25.6	.20	6.1	.14	0.95	[e]	0.00	0.00
	25-29	26.1	.13	6.0	.10	0.95	[e]	0.00	0.00
	30-34	25.4	.04	5.8	.02	0.95	0.01	0.83	0.83
	35-39	25.1	.07	5.3	.06	0.91	0.01	0.43	0.43
	40-44	25.3	.07	5.5	.06	0.88	0.01	0.84	0.84
	45-49	25.2	.06	5.2	.05	0.87	0.01	0.27	0.27

[a] Of the estimates.

[b] Proportion ever having a birth by age 50.

[c] *P* value for overall quality of fit of the data to the model, equalling 1.00 if the fit is perfect and 0.00 if the fit is poor.

[d] How similar the cohorts are in following the same natality schedule, equalling 1.00 if they follow the same curve and 0.00 if they do not follow the same natality schedule.

[d] When the estimated proportion ever having a birth was greater than 1.01, its value was fixed at a more plausible level and the model was run again. In such cases, where the proportion having a birth was fixed, there is no standard error.

ANNEX III

Alternative estimates for marriage

Country	Age group	Mean age	Std. error[a]	Std. deviation	Std. error[a]	Prop. ever married[b]	Std. error[a]	Quality of fit[c]	Homog. of cohorts[d]
Africa									
Benin	20-24	20.9	.32	5.7	.25	1.28	0.04	0.97	0.03
	25-29	19.2	.19	4.9	.16	1.04	0.01	0.10	0.08
Cameroon	20-24	18.6	.19	4.9	.15	1.09	0.02	0.00	0.00
Ghana	20-24	19.8	.21	4.6	.17	1.13	0.02	0.00	0.77
	25-29	19.5	.18	4.7	.15	1.04	0.01	0.00	0.01
Kenya	20-24	20.4	.30	5.6	.24	1.12	0.04	0.00	0.11
	25-29	19.3	.16	5.1	.14	1.04	0.01	0.00	0.01
Lesotho	20-24	19.9	.20	4.8	.17	1.09	0.02	0.02	0.02
Egypt	20-24	20.3	.13	5.6	.12	0.94	[e]	0.01	0.43
	20-24	20.5	.13	5.7	.12	0.96	[e]	0.00	0.43
Mauritania	20-24	17.4	.14	5.8	.13	0.94	[e]	0.00	0.16
	20-24	17.5	.13	5.9	.13	0.95	[e]	0.00	0.16
Sudan (North)	20-24	19.6	.19	6.9	.19	0.91	[e]	0.06	0.39
	20-24	20.0	.18	7.2	.19	0.94	[e]	0.03	0.39
Tunisia	20-24	24.0	.21	6.1	.19	0.95	[e]	0.00	0.08
Asia and the Pacific									
Jordan	20-24	20.2	.13	5.4	.13	0.91	[e]	0.00	0.26
	20-24	20.4	.12	5.5	.14	0.93	[e]	0.00	0.26
Turkey	20-24	20.6	.41	5.6	.32	1.07	0.05	0.00	0.17
Yemen	20-24	16.5	.19	4.5	.17	1.04	0.01	0.63	0.58
	25-29	16.8	.22	5.0	.19	1.02	0.01	0.00	0.01
Nepal	20-24	17.5	.20	5.3	.17	1.10	0.01	0.00	0.24
	25-29	16.6	.16	4.8	.14	1.02	0.00	0.04	0.46

Fiji	20-24	22.3	.38	5.7	.28	1.14	0.05	0.35	0.26
	25-29	20.9	.18	5.7	.10	1.04	0.01	0.01	0.91
Indonesia	20-24	18.8	.23	5.7	.18	1.03	0.02	0.00	0.00
Malaysia	20-24	24.2	.64	7.2	.45	1.12	0.08	0.26	0.21
	25-29	22.5	.30	7.0	.24	1.03	0.02	0.27	0.59
Philippines	20-24	24.0	.18	6.9	.16	0.87	[e]	0.00	0.00
	20-24	24.2	.18	7.1	.16	0.89	[e]	0.00	0.00
	20-24	24.4	.16	7.2	.15	0.91	[e]	0.00	0.00
	25-29	22.5	.15	5.8	.13	0.89	[e]	0.00	0.12
	25-29	22.7	.15	6.0	.12	0.91	[e]	0.09	0.12
Republic of Korea	20-24	28.0	.81	7.1	.52	2.08	0.25	0.33	0.53
	25-29	23.7	.16	4.5	.14	1.09	0.01	0.00	0.00
Americas									
Paraguay	20-24	21.8	.23	5.6	.21	0.93	[e]	0.45	0.54
	20-24	21.9	.23	5.7	.21	0.94	[e]	0.43	0.54
Peru	20-24	23.0	.11	6.6	.13	0.95	[e]	0.08	0.89
Mexico	20-24	21.4	.35	5.9	.26	1.02	0.04	0.01	0.13
Panama	20-24	22.9	.59	6.7	.46	1.17	0.08	0.12	0.15
Haiti	25-29	21.2	.39	5.9	.35	1.02	0.03	0.99	0.99
	30-34	21.1	.38	5.9	.33	1.02	0.02	0.05	0.03
Jamaica	25-29	19.1	.23	4.8	.21	1.04	0.01	0.02	0.13
Europe									
Portugal	20-24	24.5	.26	6.0	.18	1.08	0.05	0.13	0.13
	25-29	24.5	.14	6.1	.11	1.05	0.02	0.00	0.00

[a] Of the estimates.

[b] Proportion ever marrying by age 50.

[c] *P* value for overall quality of fit of the data to the model, equalling 1.00 if the fit is perfect and 0.00 if the fit is poor.

[d] How similar the cohorts are in following the same nuptiality schedule, equalling 1.00 if they follow the same curve and 0.00 if they do not follow the same nuptiality schedule.

[e] When the estimated proportion ever marrying was greater than 1.01, its value was fixed at a more plausible level and the model was run again. In such cases, where the proportion ever marrying was fixed, there is no standard error.

ANNEX IV

Alternative estimates for birth

Country	Age group	Mean age	Std. error[a]	Std. deviation	Std. error[a]	Prop. ever having birth[b]	Std. error[a]	Quality of fit[c]	Homog. of cohorts[d]
Africa									
Benin	20-24	24.2	.58	6.8	.41	1.62	0.10	0.00	0.17
	25-29	21.0	.25	5.2	.21	1.06	0.02	0.00	0.31
Cameroon	20-24	20.2	.21	4.5	.16	1.08	0.03	0.00	0.05
Ghana	20-24	21.2	.30	4.7	.23	1.13	0.04	0.08	0.87
	25-29	21.1	.18	4.9	.15	1.03	0.01	0.00	0.22
Côte d'Ivoire	20-24	19.7	.19	4.2	.16	1.10	0.02	0.01	0.06
Kenya	20-24	20.9	.27	5.3	.21	1.15	0.03	0.00	0.13
	25-29	19.8	.10	4.7	.06	1.02	0.01	0.00	0.25
Lesotho	20-24	22.8	.38	6.0	.31	1.21	0.05	0.35	0.20
	25-29	22.1	.17	5.3	.06	1.02	0.01	0.31	0.23
Nigeria	25-29	20.5	.20	5.5	.16	1.02	0.01	0.03	0.09
Egypt	20-24	22.5	.14	5.7	.13	0.96	[e]	0.20	0.83
Morocco	20-24	23.8	.71	6.7	.51	1.11	0.10	0.03	0.04
Sudan (North)	20-24	21.8	.19	7.0	.20	0.92	[e]	0.41	0.64
	20-24	21.9	.18	7.0	.19	0.93	[e]	0.39	0.64
Asia and the Pacific									
Jordan	20-24	21.6	.12	5.1	.14	0.91	[e]	0.05	0.89
	20-24	21.8	.12	5.2	.14	0.93	[e]	0.02	0.89
Turkey	20-24	23.5	.60	6.8	.44	1.23	0.08	0.21	0.11
Yemen	20-24	20.9	.35	5.4	.31	1.12	0.04	0.28	0.51
	25-29	20.6	.27	5.4	.25	1.04	0.01	0.01	0.01
Nepal	20-24	22.5	.37	5.6	.28	1.21	0.05	0.01	0.01
Pakistan	20-24	20.7	.17	4.8	.16	0.93	[e]	0.07	0.22

Sri Lanka	20-24	26.4	.24	7.9	.23	0.90	[e]	0.66	0.81
	20-24	26.6	.25	8.0	.23	0.92	[e]	0.65	0.81
Fiji	20-24	24.7	.62	6.3	.42	1.25	0.11	0.01	0.75
Indonesia	20-24	22.4	.36	6.5	.27	1.16	0.04	0.00	0.00
Philippines	20-24	24.0	.16	5.8	.14	0.82	[e]	0.26	0.28
	20-24	24.7	.07	6.2	.09	0.90	[e]	0.12	0.28
	25-29	24.0	.15	5.8	.13	0.90	[e]	0.00	0.02
Republic of Korea	20-24	28.2	1.15	6.6	.74	1.77	0.34	0.07	0.34
	25-29	25.4	.19	4.8	.16	1.14	0.02	0.00	0.09
Americas									
Colombia	20-24	23.5	.65	6.4	.46	1.07	0.09	0.01	0.04
Peru	20-24	24.2	.54	6.6	.39	1.02	0.07	0.18	0.44
	20-24	23.4	.10	6.1	.13	0.93	[e]	0.17	0.44
	25-29	23.1	.12	6.2	.13	0.93	[e]	0.00	0.75
Mexico	20-24	22.3	.37	5.4	.27	1.01	0.05	0.03	0.07
Panama	20-24	22.9	.64	5.7	.47	1.02	0.09	0.15	0.11
Haiti	20-24	27.0	1.70	8.2	1.10	1.34	0.28	0.12	0.18
	30-34	24.0	.10	6.9	.21	1.04	0.02	0.12	0.28
Jamaica	20-24	20.0	.18	4.0	.16	0.96	[e]	0.12	0.52
Europe									
Portugal	20-24	27.2	.38	7.1	.23	1.32	0.10	0.02	0.02
	25-29	26.7	.22	6.5	.16	1.12	0.03	0.00	0.00

[a] Of the estimates.

[b] Proportion ever having a birth by age 50.

[c] *P* value for overall quality of fit of the data to the model, equalling 1.00 if the fit is perfect and 0.00 if the fit is poor.

[d] How similar the cohorts are in following the same natality schedule, equalling 1.00 if they follow the same curve and 0.00 if they do not follow the same natality schedule.

[e] When the estimated proportion ever having a birth was greater than 1.01, its value was fixed at a more plausible level and the model was run again. In such cases, where the proportion having a birth was fixed, there is no standard error.

ERRATUM

Palloni, Alberto and Heligman, Larry, "Re-estimation of structural parameters to obtain estimates of mortality in developing countries," *Population Bulletin of the United Nations,* No. 18 (1985), pp. 10-33.

A number of readers have pointed out that some of the coefficients for early age mortality estimation published in tables 2A, 2B, 3, 5A, 5B, 6 and 7 are incorrect. Corrected tables are presented on the following pages.

TABLE 2A. ESTIMATES OF REGRESSION COEFFICIENTS FOR SPECIFICATION $M_{x,x+5} = a + b\text{PAR1} + c\text{PAR2}$ FOR CONVENTIONAL AGE GROUPS

Age group	*a*	*b*	*c*	R^2	*RMSE*	*Mean*	i_x
			Latin American model				
15-19.....	1.0865	−1.4553	.3581	.912	.0166	1.0559	1
20-24.....	1.2102	−.4692	−.1787	.985	.0051	1.0388	2
25-29.....	1.1764	.0730	−.3629	.993	.0026	.9885	3
30-34.....	1.1806	.3115	−.4230	.884	.0089	.9969	5
35-39.....	1.2028	.4075	−.4491	.761	.0132	1.0198	10
40-44.....	1.1791	.4088	−.4428	.732	.0139	.9998	15
45-49.....	1.1636	.3838	−.4322	.758	.0129	.9861	20
			Chilean model				
15-19.....	1.1906	−1.3677	.3316	.908	.0161	1.1592	1
20-24.....	1.1952	−.3163	−.1475	.984	.0038	1.0649	2
25-29.....	1.1410	.0662	−.2559	.990	.0020	1.0107	3
30-34.....	1.1275	.2115	−.2888	.879	.0063	1.0010	5
35-39.....	1.1379	.2756	−.3220	.782	.0092	1.0041	10
40-44.....	1.1397	.3162	−.3676	.769	.0109	.9872	15
45-49.....	1.1565	.3607	.4242	.781	.0122	.9799	20
			South Asian model				
15-19.....	1.0876	−1.5053	.3762	.909	.0173	1.0587	1
20-24.....	1.2186	−.4589	−.1838	.984	.0054	1.0474	2
25-29.....	1.1807	.0854	−.3556	.991	.0032	1.0005	3
30-34.....	1.1761	.3038	−.3932	.870	.0088	1.0093	5
35-39.....	1.1789	.3680	−.3855	.732	.0119	1.0264	10
40-44.....	1.1392	.3294	−.3345	.692	.0112	1.0084	15
45-49.....	1.1072	.2541	−.2731	.726	.0087	.9981	20
			Far Eastern model				
15-19.....	1.0664	−1.1081	.2931	.901	.0131	1.0545	1
20-24.....	1.1573	−.3649	−.1314	.987	.0036	1.0278	2
25-29.....	1.1369	.0433	−.2929	.994	.0020	.9822	3
30-34.....	1.1492	.2480	−.3740	.903	.0076	.9819	5
35-39.....	1.1932	.3732	−.4646	.811	.0126	.9956	10
40-44.....	1.2115	.4767	−.5683	.785	.0163	.9730	15
45-49.....	1.2472	.5697	−.6646	.780	.0192	.9702	20
			General model				
15-19.....	1.0783	−1.2546	.3156	.910	.0144	1.0557	1
20-24.....	1.1822	−.4134	−.1537	.986	.0043	1.0332	2
25-29.....	1.1554	.0579	−.3265	.993	.0022	.9851	3
30-34.....	1.1631	.2805	−.3953	.892	.0082	.9898	5
35-39.....	1.1952	.3879	−.4445	.779	.0127	1.0117	10
40-44.....	1.1860	.4235	−.4724	.750	.0144	.9927	15
45-49.....	1.1853	.4319	−.4897	.762	.0145	.9838	20

NOTES: All numbers significant at less than .01 level.
RMSE is root of the mean square errors in $M_{x,x+5}$.
Mean is the average of $M_{x,x+5}$.
i_x is the corresponding age of child.

TABLE 2B. ESTIMATES OF REGRESSION COEFFICIENTS FOR SPECIFICATION $M_{x,x+5} = a + b\text{PAR1} + c\text{PAR2} + d\text{AVE}$ FOR CONVENTIONAL AGE GROUPS

Age group	*a*	*b*	*c*	*d*	R^2	*RMSE*	*Mean*	i_x
			Latin American model					
15-19.....	.6892	−1.6937	.6464	.0106	.934	.0145	1.0559	1
20-24.....	1.3625	−.3778	−.2892	−.0041	.991	.0040	1.0388	2
25-29.....	1.0877	.0197 *	−.2986	.0024	.996	.0018	.9885	3
30-34.....	.7500	.0532	−.1106	.0115	.997	.0015	.9969	5
35-39.....	.5605	.0222	.0170	.0171	.999	.0008	1.0198	10
40-44.....	.5024	.0028 **	.0048 *	.0180	.999	.0003	.9998	15
45-49.....	.5326	.0052 **	.0256 *	.0168	.999	.0005	.9861	20
			Chilean model					
15-19.....	.8274	−1.5854	.5949	.0097	.928	.0143	1.1592	1
20-24.....	1.3129	−.2457	−.2329	−.0031	.991	.0029	1.0649	2
25-29.....	1.0632	.0196 *	−.1996	.0021	.996	.0012	1.0107	3
30-34.....	.8236	.0293	−.0684	.0081	.998	.0009	1.0020	5
35-39.....	.6895	.0068	.0032	.0119	.999	.0003	1.0041	10
40-44.....	.6098	−.0014 **	.0166 *	.0141	.999	.0004	.9872	15
45-49.....	.5615	.0040 **	.0073 *	.0159	.999	.0008	.9799	20
			South Asian model					
15-19.....	.6749	−1.7580	.6805	.0109	.931	.0151	1.0587	1
20-24.....	1.3716	−.3652	−.2966	−.0041	.990	.0044	1.0474	2
25-29.....	1.0899	.0299 *	−.2887	.0024	.996	.0025	1.0005	3
30-34.....	.7694	.0548	−.0934	.0108	.996	.0019	1.0093	5
35-39.....	.6156	.0231	.0298	.0149	.998	.0013	1.0264	10
40-44.....	.6077	.0040 **	.0573	.0141	.999	.0010	1.0084	15
45-49.....	.6952	.0018 **	.0306	.0109	.999	.0006	.9981	20
			Far Eastern model					
15-19.....	.7194	−1.3143	.5432	.0093	.903	.0110	1.0545	1
20-24.....	1.2671	−.2996	−.2105	−.0029	.992	.0028	1.0278	2
25-29.....	1.0668	.0017 *	−.2424	.0019	.997	.0014	.9822	3
30-34.....	.7833	.0307	−.1103	.0098	.998	.0012	.9819	5
35-39.....	.5765	.0068	−.0202	.0165	.999	.0007	.9956	10
40-44.....	.4115	.0014 **	.0083	.0213	.999	.0007	.9730	15
45-49.....	.3071	.0111	.0129	.0251	.999	.0009	.9702	20
			General model					
15-19.....	.7210	−1.4686	.5746	.0095	.9335	.0124	1.0557	1
20-24.....	1.3115	−.3360	−.2475	−.0034	.992	.0033	1.0332	2
25-29.....	1.0768	.0109 *	−.2695	.0021	.997	.0015	.9851	3
30-34.....	.7682	.0439	−.1090	.0105	.997	.0013	.9898	5
35-39.....	.5769	.0176	.0038	.0165	.999	.0007	1.0117	10
40-44.....	.4845	.0034	.0036	.0187	.999	.0002	.9927	15
45-49.....	.4760	.0071	.0246	.0189	.999	.0005	.9838	20

NOTES: * not significant at .01 level; ** not significant at .05 level; all others significant at less than .01 level.

RMSE is root of the mean square errors in $M_{x,x+5}$.

Mean is the average of $M_{x,x+5}$.

i_x is the corresponding age of child.

TABLE 3. ESTIMATES OF REGRESSION COEFFICIENTS FOR SPECIFICATION $M_{x,x+5} = a + b\text{PAR1} + c\text{PAR2}$ FOR UNCONVENTIONAL AGE GROUPS

Age group	*a*	*b*	*c*	R^2	*RMSE*	*Mean*	i_x
			Latin American model				
18-22.....	.9680	−.5984	.2086	.939	.0096	.8907	1
23-27.....	1.1114	−.2755	−.0931	.994	.0024	.9349	2
28-32.....	1.1534	.0111	−.3068	.998	.0012	.9292	3
33-37.....	1.2123	.1690	−.4333	.974	.0040	.9552	5
			Chilean model				
18-22.....	1.0815	−.5068	.1696	.944	.0078	1.0109	1
23-27.....	1.1233	−.1845	−.0812	.994	.0017	.9911	2
28-32.....	1.1296	.0151	−.2214	.997	.0010	.9704	3
33-37.....	1.1558	.1107	−.3045	.975	.0029	.9719	5
			South Asian model				
18-22.....	.9691	−.6014	.2093	.939	.0095	.8914	1
23-27.....	1.1197	−.2619	−.0983	.994	.0029	.9463	2
28-32.....	1.1580	.0252	−.3006	.997	.0026	.9461	3
33-37.....	1.2034	.1711	−.4005	.971	.0046	.9742	5
			Far Eastern model				
18-22.....	.9869	−.4672	.1649	.934	.0077	.9280	1
23-27.....	1.0875	−.2305	−.0700	.996	.0018	.9453	2
28-32.....	1.1240	−.0105	−.2543	.998	.0012	.9297	3
33-37.....	1.1869	.1212	−.3961	.979	.0038	.9379	5
			General model				
18-22.....	.9797	−.5303	.1857	.938	.0085	.9117	1
23-27.....	1.0992	−.2522	−.0811	.995	.0020	.9406	2
28-32.....	1.1376	.0018 **	−.2800	.998	.0011	.9297	3
33-37.....	1.1964	.1488	−.4107	.997	.0038	.9483	5

NOTES: * not significant at .01 level; ** not significant at .05 level; all others significant at less than .01 level.

RMSE is root of the mean square errors in $M_{x,x+5}$.

Mean is the average of $M_{x,x+5}$.

i_x is the corresponding age of child.

TABLE 5A. ESTIMATED COEFFICIENTS OF TIME REFERENCES FOR SPECIFICATION $t_{x,x+5} = a + b\text{PAR1} + c\text{PAR2}$ FOR CONVENTIONAL AGE GROUPS

Age group	*a*	*b*	*c*	R^2	*RMSE*	*Mean*	
			Latin American model				
15-19.....	1.1703	.5129	−.3850	.4637[a]	.0179	.5290	1
20-24.....	1.6955	4.1320	−.1635	.999	.0079	1.7505	2
25-29.....	1.8296	2.9020	3.4707	.999	.0112	3.6886	3
30-34.....	2.1783	−2.5688	9.0883	.975	.1130	6.2683	5
35-39.....	2.8836	−10.3282	15.4301	.887	.3370	9.2451	10
40-44.....	4.4580	−17.1809	20.4296	.797	.5641	12.4953	15
45-49.....	6.9351	−19.3871	23.4007	.789	.6685	16.2597	20
			Chilean model				
15-19.....	1.3092	1.9474	−.7982	.773[a]	.0297	.6748	1
20-24.....	1.6897	4.6176	−.0173	.999	.0094	1.9195	2
25-29.....	1.8368	2.6370	4.0305	.999	.0105	3.9607	3
30-34.....	2.2036	−3.3520	9.9233	.978	.1337	6.6333	5
35-39.....	2.9955	−11.4013	16.3441	.875	.3702	9.6899	10
40-44.....	4.7734	−17.8850	20.8883	.787	.5881	12.9500	15
45-49.....	7.4495	−19.0513	23.0529	.788	.6607	16.6323	20
			South Asian model				
15-19.....	1.1922	.7940	−.5425	.477[a]	.0240	.5203	1
20-24.....	1.7173	4.3117	−.1653	.998	.0097	1.7964	2
25-29.....	1.8631	2.8767	3.5848	.999	.0241	3.7595	3
30-34.....	2.1808	−2.7219	9.3705	.976	.1267	6.3561	5
35-39.....	2.7654	−10.8808	16.2255	.884	.3619	9.4041	10
40-44.....	4.1378	−18.6219	22.2390	.797	.6162	12.8468	15
45-49.....	6.4885	−22.2001	26.4911	.788	.7633	16.9556	20
			Far Eastern model				
15-19.....	1.2779	1.5714	−.6994	.707[a]	.0274	.6384	1
20-24.....	1.7471	4.2638	−.0752	.998	.0099	1.8729	2
25-29.....	1.9107	2.7285	3.5881	.999	.0119	3.8147	3
30-34.....	2.3172	−2.6259	9.0238	.973	.1185	6.3783	5
35-39.....	3.2087	−9.8891	14.7339	.885	.3260	9.2784	10
40-44.....	5.1141	−15.3263	18.2507	.800	.5097	12.2715	15
45-49.....	7.6383	−15.5739	19.7669	.804	.5557	15.5924	20
			General model				
15-19.....	1.2136	.9740	−.5247	.574[a]	.0216	.5775	1
20-24.....	1.7025	4.1569	−.1232	.999	.0086	1.7842	2
25-29.....	1.8360	2.8632	3.5220	1.00	.0105	3.7180	3
30-34.....	2.1882	−2.6521	9.1691	.974	.1162	6.3107	5
35-39.....	2.9682	−10.3053	15.3161	.885	.3371	9.2719	10
40-44.....	4.6526	−16.6920	19.8534	.796	.5500	12.4510	15
45-49.....	7.1425	−18.3021	22.4168	.793	.6371	16.0975	20

NOTES: All numbers significant at less than .01 level.

RMSE is root of the mean square errors in $t_{x,x+5}$.

Mean is the average of $t_{x,x+5}$.

i_x is the corresponding age of child.

Low R^2 for first age groups is explained by the lack of variance of the calculated values of $t_{x,x+5}$.

TABLE 5B. ESTIMATED COEFFICIENTS OF TIME REFERENCES FOR SPECIFICATION $t_{x,x+5} = a + b\text{PAR1} + c\text{PAR2}$ FOR UNCONVENTIONAL AGE GROUPS

Age group	*a*	*b*	*c*	R^2	*RMSE*	*Mean*	i_x
			Latin American model				
18-22.....	1.2284	2.1678	−1.0366	.793[a]	.0610	.789	1
23-27.....	1.8286	4.8413	−.6624	.992	.0328	2.718	2
28-32.....	1.4850	3.9584	3.5212	.998	.0242	5.148	3
33-37.....	.5814	−.4234	10.8981	.992	.0804	8.035	5
			Chilean model				
18-22.....	1.4559	2.8118	−1.2691	.830[a]	.0217	1.103	1
23-27.....	1.8747	5.0884	−.4812	.995	.0289	2.994	2
28-32.....	1.4213	3.7571	4.1666	.998	.0531	5.486	3
33-37.....	.4240	−1.0379	11.9958	.991	.0814	8.489	5
			South Asian model				
18-22.....	1.2437	2.3440	−1.1305	.779[a]	.0287	.814	1
23-27.....	1.8602	4.9234	−.6418	.993	.0370	2.786	2
28-32.....	1.4934	3.9589	3.6727	.998	.0681	5.228	3
33-37.....	.4611	−.5312	11.3917	.991	.1051	8.154	5
			Far Eastern model				
18-22.....	1.3942	2.4608	−1.1379	.806[a]	.1754	1.003	1
23-27.....	1.9036	4.7825	−.5379	.993	.0517	2.786	2
28-32.....	1.5659	3.7813	3.6471	.998	.0656	5.268	3
33-37.....	.8021	−.4850	10.7110	.992	.1554	8.123	5
			General model				
18-22.....	1.2951	2.2773	−1.0736	.800[a]	.0245	.881	1
23-27.....	1.8448	4.8051	−.6135	.992	.0355	2.757	2
28-32.....	1.4726	3.9214	3.6057	.998	.0658	5.185	3
33-37.....	.5972	−.5081	10.9786	.992	.0988	8.079	5

NOTES: All numbers significant at less than .01 level.

RMSE is root of the mean square errors in $t_{x,x+5}$.

Mean is the average of $t_{x,x+5}$.

i_x is the corresponding age of child.

Low R^2 for first age groups is explained by the lack of variance of the calculated values of $t_{x,x+5}$.

TABLE 6. ESTIMATES OF REGRESSION COEFFICIENTS FOR SPECIFICATION $M_{d,d+5} = a + b\text{PAR1} + c\text{PAR2}$ FOR MARITAL DURATION GROUPS[a]

Age group	*a*	*b*	*c*	R^2	*RMSE*	*Mean*	i_x
			Latin American model				
0-4	1.3181	−.5453	.1286	.9932	.00008	1.2047	2
5-9	1.2464	−.3530	−.1163	.9997	.00005	1.0281	3
10-14.....	1.3198	.0770	−.4607	.9995	.00006	1.0145	5
15-19.....	1.3941	.3337	−.6712	.9942	.0003	1.0332	10
20-24.....	1.3930	.3187	−.6875	.9890	.0005	1.0147	15
25-29.....	1.3909	.2328	−.6543	.9742	.0007	1.0041	20
30-34.....	1.4128	.2505	−.6892	.9806	.0007	1.0073	25
			Chilean model				
0-4	1.2632	−.4131	.0952	.9938	.00006	1.1757	2
5-9	1.1890	−.2239	−.0950	.9997	.00004	1.0351	3
10-14.....	1.2208	.0662	−.3192	.9995	.00004	1.0141	5
15-19.....	1.2647	.2204	−.4584	.9950	.0002	1.0155	10
20-24.....	1.2978	.2222	−.5239	.9861	.0003	1.0016	15
25-29.....	1.3550	.2103	−.6008	.9829	.0005	.9982	20
30-34.....	1.4281	.2706	−.7246	.9849	.0005	1.0045	25
			South Asian model				
0-4	1.3265	−.5606	.1333	.9926	.00010	1.2111	2
5-9	1.2502	−.3447	−.1149	.9997	.0001	1.0367	3
10-14.....	1.3083	.0845	−.4369	.9994	.0002	1.0239	5
15-19.....	1.3496	.3121	−.5962	.9929	.0003	1.0359	10
20-24.....	1.3150	.2675	−.5503	.9799	.0006	1.0178	15
25-29.....	1.2677	.1567	−.4392	.9634	.0006	1.0090	20
30-34.....	1.2406	.1403	−.3974	.9762	.0005	1.0059	25
			Far Eastern model				
0-4	1.2419	−.4122	.0965	.9934	.00005	1.1556	2
5-9	1.1939	−.2840	−.0943	.9997	.00004	1.0176	3
10-14.....	1.2656	.0485	−.3892	.9997	.00005	1.0011	5
15-19.....	1.3675	.2775	−.6303	.9962	.0002	1.0147	10
20-24.....	1.4486	.3317	−.7957	.9888	.0003	.9961	15
25-29.....	1.5633	.3588	−.9649	.9834	.0006	.9982	20
30-34.....	1.6638	.4525	−1.1344	.9825	.0007	1.0110	25
			General model				
0-4	1.2941	−.4986	.1173	.9932	.00007	1.1902	2
5-9	1.2265	−.3248	−.1078	.9997	.00004	1.0250	3
10-14.....	1.2964	.0648	−.4301	.9996	.00005	1.0086	5
15-19.....	1.3809	.3099	−.6492	.9949	.00021	1.0269	10
20-24.....	1.4056	.3186	−.7115	.9838	.0005	1.0097	15
25-29.....	1.4352	.2661	−.7328	.9777	.0006	1.0039	20
30-34.....	1.4732	.2991	−.7947	.9811	.0007	1.0095	25

NOTES: All numbers significant at less than .01 level.

RMSE is root of the mean square errors in $M_{d,d+5}$.

Mean is the average of $M_{d,d+5}$.

i_x is the corresponding age of child.

[a] The ages of estimation were 2, 3, 5, 10, 15, 20 and 25 for duration groups 0-4, 5-9, . . . , 40-44, respectively.

TABLE 7. ESTIMATED COEFFICIENTS OF TIME REFERENCES FOR SPECIFICATION $t_{d,d+5} = a + b\text{PAR1} + c\text{PAR2}$ FOR MARITAL DURATION GROUPS

Duration group (in years)	*a*	*b*	*c*	R^2	*RMSE*	*Mean*	i_x
			Latin American model				
0-4	1.9413	.0750	−.0119	.8800	.0126	1.4042	2
5-9	2.1905	3.6285	−.2235	.9999	.0050	2.9038	3
10-14.....	1.2889	3.5121	4.6440	.9995	.0048	5.4921	5
15-19.....	−.9784	−2.7698	15.1849	.9999	.0438	8.4969	10
20-24.....	−3.0367	−10.4675	26.5536	.9963	.1305	11.775	15
25-29.....	−2.4804	−13.2169	31.8843	.9863	.2189	15.1596	20
30-34.....	−1.5124	−12.8783	36.5354	.9842	.2503	19.6330	25
			Chilean model				
0-4	1.5502	.7134	−.1954	.9830	.0100	1.1788	2
5-9	1.9861	4.2179	−.0133	.9999	.0038	3.0943	3
10-14.....	.9268	3.1237	5.8022	.9996	.0035	5.8231	5
15-19.....	−1.4191	−3.9528	17.0030	.9998	.0331	8.9270	10
20-24.....	−3.2223	−11.6202	28.0375	.9957	.1119	12.2290	15
25-29.....	−1.9932	−13.4452	31.8196	.9849	.1985	15.5124	20
30-34.....	−.5056	−12.5689	35.1967	.9839	.2359	19.7843	25
			South Asian model				
0-4	1.5593	.4561	−.1348	.9744	.0135	1.1339	2
5-9	2.0207	3.9311	−.1303	.9999	.0063	2.9123	3
10-14.....	1.1478	3.5490	4.9222	.9997	.0151	5.5528	5
15-19.....	−1.2434	−2.8448	15.8069	.9998	.0532	8.6248	10
20-24.....	−3.7090	−10.8582	28.1514	.9964	.1358	12.0667	15
25-29.....	−3.8974	−14.2269	35.3066	.9875	.2177	15.7851	20
30-34.....	−3.4591	−14.8160	41.7555	.9853	.2447	20.6694	25
			Far Eastern model				
0-4	1.8976	.2380	−.0816	.9197	.0085	1.4385	2
5-9	2.2148	3.6886	−.1035	.9999	.0037	3.0378	3
10-14.....	1.3151	3.2007	4.9208	.9996	.0062	5.6063	5
15-19.....	−.6577	−3.0220	14.9400	.9998	.0341	8.5541	10
20-24.....	−1.8877	−10.0544	24.5141	.9956	.1124	11.6149	15
25-29.....	−.1997	−11.6541	27.0305	.9842	.2023	14.5250	20
30-34.....	1.1153	−10.5753	30.1156	.9846	.2437	18.4920	25
			General model				
0-4	2.0219	−.0732	−.0119	.9157	.0109	1.4854	2
5-9	2.2402	3.6178	−.2111	.9998	.0043	2.9526	3
10-14.....	1.3013	3.4958	4.7043	.9995	.0038	5.5430	5
15-19.....	−.8950	−2.8421	15.1646	.9998	.0408	8.5394	10
20-24.....	−2.6971	−10.3558	25.9914	.9961	.1232	11.7505	15
25-29.....	−1.8148	−12.7146	30.4876	.9858	.2122	15.0036	20
30-34.....	−.8001	−12.2269	34.8030	.9845	.2465	19.3369	25

NOTES: All numbers significant at less than .01 level.
RMSE is root of the mean square errors in $t_{d,d+5}$.
Mean is the average of $t_{d,d+5}$.
i_x is the corresponding age of child.

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