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An Exploratory Study of the 'Synthesis Framework' of Fertility Determination with World Fertility Survey Data

A collaboration of the International Statistical Institute, World Fertility Survey and the Panel on Fertility Determinants, Committee on Population and Demography of the National Research Council, National Academy of Sciences of the United States of America

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Preface

As part of its objective to carry out comparative analysis, the World Fertility Survey sponsored the present study jointly with the Panel on Fertility Determinants of the Committee on Population and Demography, National Research Council, National Academy of Sciences in the United States. The study was carried out by a member of the NAS Panel, Professor Richard A. Easterlin with Dr Eileen M. Crimmins. Data from WFS surveys in Colombia and Sri Lanka are analysed and compared.

A few words about the activities of the NAS Panel seem to be in order. The Committee on Population and Demography was established in April 1977 within the Commission on Behavioral and Social Sciences and Education of the National Research Council, in response to a request by the Agency for International Development (AID) of the US Department of State. Chaired by Professor Ansley J. Coale, the Committee has undertaken three major tasks: (1) to evaluate available evidence and prepare estimates of levels and trends of fertility and mortality in selected developing nations; (2) to improve the technologies for estimating fertility and mortality when only incomplete or inadequate data exist (including techniques of data collection); and (3) to evaluate the factors determining the changes in birth rates in less developed nations.

The evaluation of factors determining changes in fertility is a difficult task. Research on this topic has been carried out by scholars from several disciplines, and there is still no comprehensive theory of fertility or fertility change to guide an evaluation. Because of the state of knowledge of the causes of reductions in fertility and the difficulty of the task, the Committee and the Commission established the separately funded Panel on Fertility Determinants. This Panel, with Mr W. Parker Mauldin in the chair, includes scholars from several disciplines: anthropology, demography, economics, epidemiology, psychology, sociology and statistics. The Panel has undertaken three sets of activities. The first is a comprehensive review of past and current research on the determinants of fertility change in developing countries. The second is a series of studies of the determinants of fertility change (or lack of change) in eight countries. The third is a group of six comparative cross-national studies that attempt to advance understanding of fertility change, to improve the measurement techniques used in research on fertility determinants and to link micro and macro analyses.

In the work of the Panel and the Committee, the comparable data generated by the World Fertility Survey programme served as a major data source. Moreover, the WFS has also considered the need to introduce an 'economic' framework in the national level analysis of WFS data, a point which was voiced during the 1980 World Fertility Survey Conference held in London. The present report is the result of the collaborative project launched by the NAS Panel and WFS in this context.

The project dealt with in this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance. This report has been reviewed by a group other than the authors, following the procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

As indicated in the title of the report, the authors consider the approach and the results exploratory, but we hope the report will stimulate the interest of researchers and will lead to further contributions to the better understanding of the determinants of human fertility.

This work was accomplished with the assistance and advice of a large number of individuals, including the members of the Panel. They are listed in appendix B. However, it is our privilege to acknowledge the support and co-operation which the Panel and the WFS received from the National Directors of the fertility surveys carried out by the governments of Colombia and Sri Lanka.

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Acknowledgements

The primary data used for this analysis came from the fertility surveys in Colombia and Sri Lanka, carried out within the WFS programme. We wish to thank Mr W. A. A. S. Peiris, Director, Department of Census and Statistics, Government of Sri Lanka. The Colombian National Fertility Survey was conducted in 1976 jointly by the Corporación Centro Regional de Población (CCRP), a non-profit-making private institution devoted to research on population, and the Departmento Administrativo Nacional de Estadística (DANE), the state agency responsible for the collection, processing and publication of statistical data, with the collaboration of the Division of Information systems of the Ministry of Health in the design and implementation of the sample. The co-operation of all of these organizations is gratefully acknowledged.

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Thanks are also due to the staff of the NAS Committee and ISI/WFS. In the Committee, Katherine L. M. Malin edited the report, Elaine McGarraugh handled production editing details and Carole Turley and Solvig Padilla assisted in typing the text and tables. Ms Betzy Dinesen in WFS did the technical editing and Ms Lynn Bacon of ISI saw through the printing and publication.

Finally, our thanks are also extended to the members of the Panel and Committee and the staff of the Committee and WFS who offered ideas and suggestions as part of their review responsibilities.

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1 Theory

In recent years the fertility phase of the demographic transition has come increasingly to be seen not only as a movement from initially high to eventually low levels of fertility, but also as a shift from 'natural fertility' to deliberate limitation of family size (see, eg Henry 1961, Bourgeois-Pichat 1967, Coale 1969, Srinivasan 1972). This suggests that new insight into the fertility transition may arise from focusing on the mechanisms underlying the adoption and use of deliberate control. Building on a model suggested by the 'synthesis framework' of fertility determination (see Easterlin 1975, 1978, Easterlin *et al* 1980), this paper examines to what extent data from the World Fertility Survey (chiefly from the core questionnaire) can be used to explain differences among households in the use of deliberate fertility control, and how use of fertility control is linked, on the one hand, to underlying socio-economic and cultural variables, and on the other to observed fertility. The theory of the approach is presented below followed by a description of the data in chapter 2, and the empirical results in chapters 3 to 6.

The theoretical approach involves a three-stage analysis of fertility. The first is an 'intervening variables' analysis, linking fertility and its proximate determinants (Davis and Blake 1956, Bongaarts 1978). The second focuses on one intervening variable, the use of fertility control, and analyses differences among households in the extent of control in terms of differences in motivation and costs of regulation. The third takes as its dependent variables the independent variables of stages one and two and analyses each in terms of differences in social, economic and cultural conditions.

To simplify the analysis, the theory focuses on the fertility of continuously married couples (including common law marriages) and assumes that fertility control is undertaken to limit family size and not for spacing births. The typical couple's decision about whether or not to limit family size is viewed not as a highly formal decision but as a gradual response to the balance between several types of pressures.

The theory on which the analysis of fertility control (stage two of the analysis) is based starts by formalizing certain concepts commonly found in sociological studies of fertility determination (see, for example, Freedman 1961–62, Petersen 1969) and linking these concepts to the micro-economics of fertility. Decisions regarding deliberate fertility regulation are commonly seen in the sociological literature as involving three types of considerations: motivation, attitudes and access. The motivation for fertility regulation is viewed as stemming from concerns about having too many children or having them too soon. Attitudes toward fertility regulation embrace both very broad notions of the acceptability of family planning in general as well as feelings about the appropriateness of specific practices. Access pertains to the availability (including both time and money costs) of fertility control services and supplies. In general, fertility regulation is viewed as varying directly with the degree of motivation, favourableness of attitudes and extent of access.

These notions can be formalized in terms of three concepts:

1 Costs of fertility regulation (RC): this combines a couple's attitudes toward and access to fertility control services and supplies. It includes both subjective disadvantages of regulation and the economic costs of control.
2 Desired family size (Cd): this is the number of surviving children a couple would want in a 'perfect contraceptive society', one where costs of regulation were negligible (see Bumpass and Westoff 1970). It reflects the taste, income and price considerations of the usual economic theory of household decision making, including both the economic and non-economic returns from children as well as their costs.
3 Potential family size (Cn): this is the number of surviving children a household would have if it did nothing deliberately to regulate its fertility. Potential family size is the product of a couple's natural (or non-controlled) fertility (N), and its child survival rate (s). Both natural fertility and potential family size may be well below the biological maximum because of general cultural conditions that tend to reduce fertility and family size (such as prolonged breastfeeding).

The excess of potential family size over desired family size, Cn − Cd, is the number of unwanted children a couple would have in the absence of deliberate fertility control. The larger this excess, the greater is the potential burden of unwanted children, and consequently the greater is the household's motivation to limit its fertility. It is worth stressing here the two-sided view of how motivation is determined. Often motivation is simply identified with desired family size and it is assumed that only if this decreases will motivation grow. In fact, however, an increase in potential family size can increase motivation, even if desired family size remains constant, because it increases the potential number of unwanted children. An increase in potential family size might arise from an increase in a couple's natural fertility, improved chances of child survival, or both.

The value of Cn − Cd may be negative, indicating that a household is in a 'deficit fertility' situation, that is, that it is unable to produce as many children as it would like to have. In this case, there is no motivation to limit fertility and a couple would have as many children as possible; in other words 'natural fertility' would be a logical outcome of the couple's underlying reproductive conditions.

Even if the value of Cn − Cd is positive, however, it does not necessarily follow that a couple will deliberately control its fertility. Against the pressure to do so must be weighed the costs of fertility control, RC, that is, the subjective disutility and economic costs attached to the actual use of control. If RC is high and the motivation (Cn − Cd) low, then a couple may feel that the disadvantages of unwanted children are less than those associated with deliberately restricting fertility, and hence may forego fertility control. Again, unregulated fertility may be a rational response to the couple's basic situation.

In general, the probability of adopting control is higher the greater the degree of motivation (the excess of potential over desired family size) and the lower the costs of regulation. The theory thus leads in the second-stage analysis to comparing households in terms of motivation for control and costs of control to see if these theoretical determinants are, in fact, systematically associated with differences in the use of fertility control.

The third-stage analysis links the independent variables of the first two stages to what might be called 'basic fertility determinants': socio-economic and cultural variables, such as education, occupation, ethnic group and so on. For the intervening variables other than fertility control in the first-stage analysis (marital duration, foetal wastage, etc) the approach is the usual one: the basic determinants are seen as operating directly on each of these variables. In the case of fertility control, however, each of the basic determinants is seen as potentially working through the independent variables of stage two: desired family size, potential family size, and costs of regulation, with the direction and magnitude of effect possibly varying from one determinant to another (for a good exposition of this view, see Cochrane 1979). An important implication of this is that the bivariate relation between use of control and a given basic determinant is not invariant, but may alter depending upon which mechanisms predominate at a given time. Thus in the present theory the basic determinants are seen as affecting fertility not directly but via their impact either through the determinants of fertility control or through the intervening variables other than fertility control.

2 Data and Methods

Although the two countries used for the initial test of the theory, Sri Lanka and Colombia, are at rather similar stages in the transition to deliberate fertility control, they are different in a number of other characteristics (see Corporación Centro Regional de Poblacion, Colombia 1977; Department of Census and Statistics, Sri Lanka 1978). The population of Sri Lanka, almost 13 million in 1971, is divided into four major ethnic groups. The Sinhalese (72 per cent) are predominantly Buddhist with a small Christian minority; the Sri Lanka Tamils (11 per cent) and Indian Tamils (9 per cent), are both largely Hindu and of Indian origin, but the latter are relatively recent immigrants concentrated on the rubber and tea estates and comprising the bulk of the 'estate population'. The Sri Lanka Moors (7 per cent), exclusively Muslim, originate from early Arab traders. Although the island is fairly small, there is considerable ecological diversity, ranging from lowlands to hilly and mountainous areas and from wet to dry regions.

Colombia too has a great deal of geographical diversity, being split by the Andes mountains which cut across the country from north to south, and bordering on both the Atlantic and Pacific oceans. In total area it is over 15 times as large as Sri Lanka, but in population size it is less than twice as great. Ethnically, the population divides into Mestizo (68 per cent), European (20 per cent), Indian (7 per cent), and Negro and Mulatto (5 per cent). In the present analysis these ethnic differences can only be approximated by regional variables.

The study population is currently married females close to the end of their reproductive careers, those aged 35–44, who have been married only once (including common law marriages in Colombia), are still married, and who have had at least two live births. In Colombia women with premarital births were excluded because of lack of appropriate data on duration of union; in Sri Lanka the proportion of women with premarital births was negligible. The restriction to continuous marriages minimizes conceptual and measurement problems associated with marital disruption. Childless and parity-one women were omitted to avoid biasing the results in favour of the theory, because this group consists almost wholly of women who have never regulated their fertility and who lack the motivation to do so because they have been sterile throughout their reproductive careers or have severe fecundity problems. In Sri Lanka the study population comprised about 73 per cent of ever-married females aged 35–44: in Colombia, 56 per cent. The smaller figure for Colombia reflects the higher incidence there of marital disruption and premarital births.

The present analysis is the final version of a brief preliminary report prepared for the 1981 quadrennial meeting of the International Union for the Scientific Study of Population (Crimmins and Easterlin 1981). Although the results presented here are similar to the earlier ones, this analysis introduces a number of refinements. The chief ones are the reduction in the population coverage (elimination of women with premarital births or fewer than two births) mentioned above, a revised approach to the estimation of natural fertility and secondary sterility, and a shift from ever-use to duration of use as the principal measure of fertility control.

The actual measures used in the empirical analysis are approximations to the conceptual ideal. They are assembled for reference in appendix A and discussed individually in the analysis. For the most part they are taken directly as reported in the surveys. The principal exceptions are duration of use of fertility control, secondary sterility and natural fertility, all of which were estimated. In estimating relationships among variables, linear regressions fitted to household data by the technique of ordinary least squares were used throughout.

The emphasis here on simple measures and techniques reflects the fundamental concern with laying out and implementing empirically the analytical structure as a whole in a way that can be readily understood and replicated in order to facilitate comparisons among countries. The key question is: using simple techniques and minimal refinement of WFS data, can one advance the understanding of the mechanisms underlying fertility determination and the use of deliberate fertility control?

3 First Stage: Intervening Variables Analysis

The first step in the empirical analysis is to link fertility to its proximate determinants. The aim is not a definitive 'intervening variables' analysis – that would be a project in itself. Rather there are two purposes. One is to clarify the effect on observed fertility of the use of fertility control, the intervening variable of particular interest here. The other is to obtain an equation with a fairly robust statistical explanation of observed fertility, which can be used subsequently to obtain household-level estimates of natural fertility. We recognize that some of the variables treated below as independent, such as duration of marriage, might be treated as endogenous. We view this as an empirical question to be examined at a later time. As elsewhere in this report, the approach is guided by a desire to use the same analytical formulation in different countries in order to facilitate comparisons.

3.1 NATURE AND MEASUREMENT OF INTERVENING VARIABLES

The proximate determinants framework used here is modelled on those common in the literature (Henry 1953, Davis and Blake 1956, Bongaarts 1978). In general, one would expect that the cumulative fertility of a continuously married woman near the end of her reproductive career would be greater:

1 the less the use of fertility control by her or her husband;
2 the longer her period of exposure, as measured by duration of marriage;
3 the more rapid her early rate of childbearing, as measured by first and second birth intervals;
4 the shorter her period of secondary sterility;
5 the shorter her duration of breastfeeding and consequent lactational amenorrhoea;
6 the lower her rate of foetal wastage (spontaneous abortions and stillbirths), and hence physiological problems of reproduction;
7 the higher the couple's rate of child mortality and consequent shortening of the non-susceptible period.

The measurement of most of these intervening variables is straightforward and is detailed in table A1. However, two variables – use of fertility control and secondary sterility – require further discussion.

Fertility Control

Fertility control refers here to the ever-use of contraception, contraceptive sterilization or induced abortion, as reported by survey respondents. Contraception includes the use both of what WFS calls 'efficient' methods (pill, IUD, diaphragm, condom and injection) and 'inefficient' methods (douche, abstinence, withdrawal and rhythm). Breastfeeding was not included by WFS as a type of control, a treatment supported in Sri Lanka and Colombia by behavioural evidence that breastfeeding has only a small or negligible association with parity (Jain and Bongaarts 1980: 7–9). Respondents who reported no use of any method were assigned fertility control values of zero. For those who reported use, a rough estimate of duration of use was made by differencing current age and actual or estimated age at first use. For the four users in Colombia who reported only abortion, duration of use was estimated as the product of number of abortions and .667 years, the average protection afforded by this method (Bongaarts 1978).

Although this measure of time since first use overestimates duration of use *per se*, the results of the 1981 IUSSP report (Crimmins and Easterlin 1981) suggest that it does give some indication of differences in length of use among households regulating fertility. For example, the statistical explanation of household differences in observed fertility is improved when this variable is used in a proximate determinants analysis, rather than a simple zero/one measure of whether households ever used fertility control (Crimmins and Easterlin 1981: table 9). Experimentation with different measures of duration of use, which allowed for the efficiency of method used by altering duration in proportion to a method's relative efficiency (using efficiency data from Bongaarts 1980), yielded no additional improvement in the statistical results.

Secondary Sterility

In the case of secondary sterility, the obvious choice for a measure was the response to a question on whether or not the respondent thought she could bear another child. However, according to this measure the average proportion of secondary sterility for continuously married women of all parities whose average age is about 39 years is unusually low – only 16 per cent in Sri Lanka and 7 per cent in Colombia. This compares with sterility estimates for women aged 40 by Henry and Vincent (reported in Pittenger 1973) of 32 to 33 per cent.

After some experimentation, the following measure of secondary sterility was adopted: women were classified as secondarily sterile if (a) they reported a fecundity impairment, or (b) they were not currently regulating their fertility, had had no child in the last five years, and were not pregnant. This measure gave proportions of secondary sterility of 36 per cent in Sri Lanka and 26 per cent in Colombia for all women aged 35–44; for women with at least two children, the proportions are slightly less: 33 and 22 per cent respectively. Those classified as secondarily sterile by this definition were assigned a value of zero on the variable; all others, a value of one.

Ideally, the measure of secondary sterility should be independent of knowledge about a woman's use or non-use of fertility control, and in that respect this surrogate measure is flawed. The problem of potential bias arises from the fact that current use of fertility control is one factor affecting the estimation of secondary sterility, which in turn enters into the estimate of Cn, a key variable in explaining duration of use, the primary dependent variable in this analysis. However, it seems likely that this potential bias, if it does exist, is of negligible proportions. First of all, among the total population, the likelihood that the measure seriously mis-estimates secondary sterility – in particular, that there is likely to be a substantial number of current users who are, in fact, secondarily sterile – seems small. The percentages yielded by the measure are consistent with more robust estimates for similar populations (Henry and Vincent's results, reported in Pittenger 197[illegible]); moreover, it seems plausible *a priori* that the number of current regulators who are secondarily sterile is negligible. In addition, if the subject population in the analysis of duration of use (see chapter 4) is limited to current regulators who are classified as not secondarily sterile, and hence to a group for whom the explanation of use cannot be influenced by differences in Cn due to differences in secondary sterility, then there is no significant reduction in the explanation of duration of use. Therefore, while the measure of secondary sterility is technically less than ideal, it appears that any distortions it may introduce are not substantive in a quantitative sense.

In addition to the variables enumerated above, several other possible intervening variables were included in the intervening variables analysis but found to be statistically not significant. These were age at marriage (both countries) and frequency of intercourse and length of postpartum abstinence (Colombia).

3.2 EMPIRICAL RESULTS

The means and standard deviations of the variables in the analysis and correlations among them are detailed in table 1. The simple correlation between the dependent variable, children ever born, and each of the independent variables has the same sign in both countries and the coefficients are often quite similar in magnitude. Among the independent variables, correlations are generally low; of the 56 correlations in the table, the highest is only .27. Again, the signs and even magnitudes of the coefficients are often quite

Table 1 Mean, standard deviation, and correlation matrix for variables in intervening variables analysis (population with two or more children)

Country and variable	Years since starting fertility control	Duration of marriage	First birth interval	Second birth interval	Not secondarily sterile	Months breast-feeding	Proportion of pregnancy wastage	Proportion of child mortality	Mean	Standard deviation
A Sri Lanka										
Children ever born	−.06[a]	.53[a]	−.13[a]	−.23[a]	.11[a]	.02	−.23[a]	.15[a]	5.68	2.53
Years since starting control		.07[a]	−.08[a]	−.13[a]	.26[a]	.03	.03	.01	4.35	5.86
Duration of marriage, years			.13[a]	.12[a]	−.27[a]	.22[a]	−.06[a]	.17[a]	19.84	5.61
First birth interval, months				.08[a]	−.01	.01	.19[a]	.07[a]	21.45	18.84
Second birth interval, months					−.11[a]	.13[a]	.05	−.05	29.24	19.39
Not secondarily sterile (= 1; others = 0)						.00	−.02	−.09[a]	.67	.47
Months breastfeeding in last closed interval							.01	−.11[a]	16.87	12.63
Proportion of pregnancy wastage								.05	.06	.12
Proportion of child mortality									.09	.15
B Colombia										
Children ever born	−.10[a]	.56[a]	−.03	−.17[a]	.10[a]	.04	−.11[a]	.26[a]	6.64	3.17
Years since starting control		.18[a]	−.09[a]	−.15[a]	.21[a]	−.21[a]	.04	−.07	7.29	6.56
Duration of marriage, years			.14[a]	.06	−.25[a]	.13[a]	−.01	.14[a]	19.38	5.20
First birth interval, months				.01	.00	.05	−.02	.11[a]	16.58	13.21
Second birth interval, months					−.13[a]	.12[a]	.16[a]	−.08[a]	23.66	15.20
Not secondarily sterile (= 1; others = 0)						−.03	−.12[a]	−.09[a]	.78	.42
Months breastfeeding in last closed interval							−.08	−.05	8.32	7.38
Proportion of pregnancy wastage								.06	.07	.12
Proportion of child mortality									.11	.17

[a]Significant at .05 level or below.
NOTE: Number of cases: Sri Lanka, 1613; Colombia, 517.

Table 2 Regression of children ever born on specified variables (population with two or more children)

Country	Years since starting fertility control	Duration of marriage	First birth interval	Second birth interval	Not secondarily sterile	Months breast-feeding	Proportion of pregnancy wastage	Proportion of child mortality	Constant
A Metric coefficient (standard error in parentheses)									
Sri Lanka	−.1081	.3169	−.0261	−.0363	1.8082	−.0160	−2.7700	.9819	.6134
	(.0077)	(.0085)	(.0023)	(.0022)	(.0990)	(.0035)	(.3719)	(.2996)	
Colombia	−.1732	.4482	−.0425	−.0412	2.5842	−.0343	−.9221	3.0852	−1.0932
	(.0157)	(.0198)	(.0072)	(.0064)	(.2423)	(.0132)	(.7870)	(.5771)	
B Standardized coefficient									
Sri Lanka	−.2501	.7019	−.1944	−.2780	.3356	−.0800	−.1282	.0567	
Colombia	−.3589	.7354	−.1771	−.1978	.3395	−.0798	−.0353	.1612	

C Summary statistics	Number of cases	$\bar{R}^2$	F
Sri Lanka	1613	.55	246
Colombia	517	.56	83

NOTE: All coefficients are significant at .05 level or below except that for proportion of pregnancy wastage in Colombia.

similar in the two countries. Although duration of breastfeeding is generally an important determinant of birth interval (Jain and Bongaarts 1980), the correlation coefficient here between breastfeeding and second birth interval gives little indication of redundancy. Probably this is because the breastfeeding variable refers to the last closed interval, and for only 10 per cent or less of the population in the two countries is the last birth interval the same as the second birth interval.

Turning to the results of the multivariate regression equation (shown in table 2), one finds that in both countries the expected directions of relationships hold and all of the coefficients are significant, except for one in Colombia. The fitted equation accounts for 55 to 56 per cent of the household variation in childbearing. The standardized coefficients indicate a rough similarity between the two countries in the relative importance of the intervening variables: in order, duration of marriage, followed by a group including fertility control, secondary sterility, and the two birth interval variables, and finally a group consisting of the breastfeeding and two mortality variables.

The metric coefficients are also generally similar in the two countries, except for the two mortality variables, whose magnitudes (disregarding sign) reverse. The impression of similarity is, however, somewhat misleading, especially as regards duration of marriage. The coefficients of this variable, about .45 in Colombia compared with .32 in Sri Lanka, would imply a cumulative difference between the two countries of 2.6 births in a marriage of twenty years duration.

With regard to the coefficient of most interest here, that of the fertility control variable, the results for Sri Lanka indicate that, other things being equal, a household that started regulating its fertility, say, ten years ago would have 1.08 fewer births than a non-regulating household, other things being equal. For Colombia, the implied effect of the same degree of fertility control is greater: 1.73 fewer births.

4 Second Stage: Use of Fertility Control

The theory sketched earlier hypothesizes that use of fertility control varies directly with the motivation for control and inversely with the costs of control. Motivation, in turn, is seen as depending on the excess of a household's potential family size over its desired size. This section takes up first the measurement of the independent variables – potential family size, desired size and costs of fertility regulation – with special attention to biases that might bear on the test of the hypothesis. The empirical results of the test and a few corollary analyses are then presented. (The variables referred to in this section are summarized in table A2:)

4.1 POTENTIAL FAMILY SIZE (Cn)

Potential family size, the number of surviving children a household would have in the absence of fertility regulation, is the product of a household's natural or non-controlled fertility (N) and its child survival rate (s). Natural fertility for each household is estimated from the equation in table 2 by setting the value for fertility control equal to zero and entering the household's actual values on all other variables. Hence differences among households in estimated natural fertility will arise from differences in any of the intervening variables other than fertility control. The results are shown in table 3.

For non-regulators, those who never used fertility control, this procedure yields a mean estimate of natural fertility that is close to, but slightly above, their true natural fertility – the actual number of children ever born (table 3, columns 1 and 2). The dispersion in their estimated natural fertility is less than the true dispersion, as one would expect, because the estimating equation accounts for only a little more than half of the total variance in the population.

Table 3 Mean and standard deviation of estimated natural fertility and children ever born (non-regulating and regulating population with two or more children)

Country	Non-regulators		Regulators	
	Estimated natural fertility	Children ever born	Estimated natural fertility	Children ever born
A Sri Lanka				
Mean	6.03	5.89	6.26	5.52
Standard deviation	1.92	2.53	1.98	2.52
Number of cases	717	717	896	896
B Colombia				
Mean	7.66	7.19	8.05	6.40
Standard deviation	2.45	3.16	2.54	3.15
Number of cases	156	156	361	361

For regulators, the mean estimated natural fertility is considerably above their actual fertility (table 3, columns 3 and 4). One would, of course, expect a difference of this type, because of the regulators' use of deliberate fertility control. Although the regulators' mean actual fertility is lower than that of non-regulators, their estimated natural fertility is higher, with about the same dispersion.

It is possible to identify quantitatively the sources of the higher natural fertility of regulators than non-regulators in terms of the specific contributions of the independent variables in the proximate determinants equation. For each independent variable in the equation the excess of the regulator's mean value over that of the non-regulators, derived from table 4, is multiplied by the appropriate regression coefficient from table 2. This calculation indicates that the higher mean natural fertility of regulators is due chiefly to their lower incidence of secondary sterility, with a small contribution also made by their shorter birth intervals and duration of breastfeeding. The other intervening variables, especially marriage duration, tend to lower the natural fertility of regulators compared with non-regulators, but their effect is outweighed by variables raising the relative natural fertility of regulators.

Because the intervening variables equation is estimated from data for the total population, the estimated mean natural fertility for the total population is more reliable than that for any component group. Since the mean natural fertility for the total population is a weighted average of the means for the regulating and non-regulating subgroups, the overestimate of the mean natural fertility of the non-regulating population implies that the mean of the regulating population is underestimated. The effect of this is to bias the results against the principal hypothesis being tested in this section: that greater use of fertility control is positively associated with higher motivation, that is, with a greater excess of potential over desired family size. This is because the estimated potential family size and, hence, motivation of regulators, is reduced relative to that of non-regulators by the downward bias in their estimated natural fertility relative to that of non-regulators.

In the IUSSP report a somewhat different approach was used in estimating natural fertility. The natural fertility of non-regulators was taken as equal to their observed fertility and that of regulators was derived from an intervening variables equation, the coefficients of which were estimated from the natural fertility population alone. The results were generally similar to those obtained here, although the difference in the means for the two groups was somewhat greater (Crimmins and Easterlin 1981, tables 1 and 2). There are two reasons for preferring the present procedure

Table 4 Mean and standard deviation of variables in regression equation of table 2 (non-regulating and regulating population with two or more children)

Variable	Sri Lanka		Colombia	
	Regulators	Non-regulators	Regulators	Non-regulators
Mean				
Children ever born	5.52	5.89	6.40	7.19
Years since starting control	7.84	0.00	10.44	0.00
Duration of marriage (years)	18.63	21.34	18.95	20.35
First birth interval (months)	20.77	22.31	15.90	18.15
Second birth interval (months)	26.31	32.89	22.28	26.87
Proportion not secondarily sterile	.88	.41	.87	.56
Months breastfeeding in last closed interval	16.02	17.94	7.41	10.44
Proportion of pregnancy wastage	.06	.05	.08	.06
Proportion of child mortality	.08	.10	.09	.15
Standard deviation				
Children ever born	2.52	2.53	3.15	3.16
Years since starting control	5.87	0.00	5.37	0.00
Duration of marriage (years)	5.72	5.07	5.26	4.94
First birth interval (months)	19.33	18.18	12.25	15.14
Second birth interval (months)	15.04	23.22	13.85	17.58
Proportion not secondarily sterile	.32	.49	.33	.50
Months breastfeeding in last closed interval	12.29	12.97	6.75	8.29
Proportion of pregnancy wastage	.12	.11	.12	.12
Proportion of child mortality	.13	.16	.15	.19
Number of cases	896	717	361	156

for estimating natural fertility. First, as a basis for testing the hypothesis regarding the relation between use of fertility control and motivation, it is preferable to adopt an approach to estimating a household's natural fertility that is the same for both regulators and non-regulators. Secondly, although the intervening variables analysis of the IUSSP report based on the non-regulating population alone yielded reasonable estimates of natural fertility for the two countries under study, it would be less likely to do so for countries with much higher levels of fertility control. In such countries, the non-regulating population is increasingly selected in terms of low fecundity, and the coefficients of an intervening variables equation estimated from this group alone would be of uncertain relevance to regulators.

To this point the concern has been with the estimation of natural (non-controlled) fertility, N. To convert this to an estimate of potential family size, Cn, an estimate is needed for each household of the child survival rate, s, the ratio of living children to children ever born. This was obtained by assuming that the survival rate actually experienced by each household would apply to its potential as well as its actual fertility. Because mortality tends to be slightly higher among higher parity children, this assumption results in a somewhat overstated rate of survival for regulators relative to non-regulators, because their excess of potential over actual fertility is greater. However, the upward bias is probably small because even for regulators the difference between estimated natural fertility and children ever born is not very great – only .74 in Sri Lanka and 1.65 in Colombia (table 3, first two columns under regulators: 6.26 − 5.52 = .74 and 8.05 − 6.40 = 1.65).

4.2 DESIRED FAMILY SIZE (Cd)

For this measure, the response to the following question was used: 'If you could choose exactly the number of children to have in your whole life, how many would that be?' The value of the response to a question of this type is sometimes questioned. To the extent that scepticism arises from lack of correlation between observed fertility and desired family size, it is not relevant here. The present framework views desired family size as only one of a number of fertility determinants, and there is no expectation that desired size alone should be highly correlated with fertility.

A more serious objection is that the response reflects the respondent's state *ex post facto*, that is after, not before, decisions regarding fertility and fertility control. Thus actual family size may bias upward responses to desired family size, because children unwanted before the fact are reported as desired after the fact. There is, however, some evidence that the magnitude of the bias is not great enough to invalidate the usefulness of responses on desired size (Knodel and Prachuabmoh 1973). Especially to the point is a recent study of the change in family size preferences of two cohorts of Taiwanese women between 1965 and 1973 (Jejeebhoy 1981). No evidence was found of an increase in desired size, despite the fact that these cohorts were at a stage in their reproductive career when most women were shifting from having fewer children than were desired to having more than desired.

An indication that the present data do to some extent reflect real differences in desires is provided by comparing the responses of regulators and non-regulators. In general, one would expect that an upward bias in desired family size would be less likely to occur among those who have fewer children than the number they report as desired. In both countries the proportion who have fewer children than the number desired is smaller among regulators than non-regulators (14 versus 22 per cent in Sri Lanka; 27 versus 40 per cent in Colombia). Thus there should be less upward bias in the responses on desired family size of non-regulators compared with regulators.

If the mean desired family size reported by non-regulators were smaller than that of regulators, then one might attribute the difference between the two groups to a smaller upward bias in the responses of non-regulators. In fact, however, the mean desired family size of non-regulators is greater than that of regulators (5.0 versus 4.4 in Sri Lanka; 5.6 versus 4.5 in Colombia; see table 5), despite the differential bias in favour of the latter. This suggests that the direction of the reported difference between the two groups is real, not a statistical artifact, although the magnitude may be understated.

The differential bias in reported desired family size of non-regulators and regulators bears on testing the hypothesized relation between use of fertility control and motivattion. According to the present reasoning, the reported desired family size of regulators relative to non regulators is exaggerated. If a downward adjustment were made to the reported desired family size of regulators, this would raise their estimated level of motivation (Cn − Cd) and tend to improve the correlation with use of fertility control. The use here of reported desired size thus biases the results against the hypothesis being tested.

4.3 COSTS OF FERTILITY REGULATION (RC)

Conceptually, in measuring the costs of fertility regulation one would like data that reflect a household's subjective attitudes towards the use of fertility control, their information about methods of control, and the economic costs of obtaining additional knowledge about techniques of control and of purchasing supplies or services needed for control. Ideally such data would antedate the actual decision on fertility regulation, because one consequence of a decision to use control is likely to be a positive shift in users relative to non-users with regard to both knowledge of methods and favourableness of attitudes. The measure(s) used must, of course, be available for all households in the study population; knowledge, say, of non-users' attitudes toward fertility control is of little value unless one knows how they differ from the attitudes of users.

The available measures fall far short of the ideal. The principal measure used here is the number of methods of fertility control known to the respondent and reported without special prompting. Several alternative measures are also explored, including the efficiency of the control methods known, and a measure relating to induced abortion: in Sri Lanka, whether or not abortion is known; in Colombia, the number of situations (out of a total of six) in which abortion is considered acceptable. In addition, the Colombia data include information on the time required and distance to be travelled to obtain family planning services, though it is reported only for a considerably smaller share of the population. However, all these measures are defective on two counts: they fail to capture subjective feelings, which may be the most important part of costs of regulation, and they are *ex post facto*, that is, they reflect the respondent's state after, not before, the fertility control decision.

The retrospective nature of the data introduces a bias favouring the hypothesis that greater use of control is inversely associated with lower costs of control (that is, greater knowledge). As noted, one would expect that those who have adopted control would be likely to know more methods of control; thus, greater knowledge may be an effect rather than cause of greater use of control. As was mentioned earlier, however, the feature of particular interest in testing the present theory of fertility control is the measure of motivation. To the extent that the measure of regulation costs is determined by, rather than independent of, the use of control, this would work against a favourable result with regard to the present measure of motivation. In other words, the endogeneity of the measure of costs of regulation, by biasing the results in favour of the association between use of control and costs of regulation, biases them against the hypothesized association between use of control and motivation.

In any event, it is possible partly to avoid the problem posed by the endogeneity of the costs of regulation measure. The bias noted relates to the situation of regulators compared with non-regulators; among the regulators themselves there should be little or no differential bias in responses on knowledge of control. Hence, the analysis below is conducted not only for the total population, but also for the regulating population alone.

4.4 ANALYSIS OF FERTILITY CONTROL

In Sri Lanka the mean duration of use of fertility control is 4.4 years; for the regulating population alone, 7.8 years (tables 1 and 4). The corresponding figures for Colombia are 7.3 and 10.4 years respectively. (As explained in chapter 3, these estimates are biased upward and are an upper limit to duration of use.) The three sections that follow examine the extent to which household differences in the use of control are related, first to the motivation for control, second to the costs of regulation, and finally to the two determinants jointly. The analysis is conducted separately for the total population and the regulating population. Where appropriate, data for the non-regulating population are included for comparison.

Motivation

Motivation is measured here by the algebraic excess of potential family size over desired size (Cn − Cd). The greater the motivation, the greater is the expected use of fertility control. For those with relatively low motivation, expected use is zero.

An initial measure of the association between use of control and motivation is given by the Pearsonian correlation coefficient between the two variables:

	Total population	Regulating population
Sri Lanka	.38	.38
Colombia	.40	.40

Table 5 Correlation matrix for years since starting fertility control and specified measures of motivation

Country and variable	Cn – Cd	Wants no more	C – Cd	Cn	Cd	C	Mean	Standard deviation
A Total population								
Sri Lanka (n = 1611)								
Years since starting fertility control	.38[a]	.21[a]	.09[a]	.23[a]	–.15[a]	–.07[a]	4.36	5.86
Cn – Cd		.25[a]	.62[a]	.44[a]	–.59[a]	–.06[a]	.92	2.00
Wants no more (= 1; others = 0)			.20[a]	.27[a]	.00	.15[a]	.74	.44
C – Cd				.40[a]	–.25[a]	.52[a]	.49	1.72
Cn					.47[a]	.71[a]	5.56	1.84
Cd						.69[a]	4.64	2.03
C							5.13	2.31
Colombia (n = 513)								
Years since starting fertility control	.40[a]	.19[a]	.12[a]	.36[a]	–.20[a]	–.09[a]	7.31	6.56
Cn – Cd		.38[a]	.82[a]	.53[a]	–.78[a]	.11[a]	2.09	3.67
Wants no more (= 1; others = 0)			.37[a]	.29[a]	–.24[a]	.19[a]	.80	.40
C – Cd				.42[a]	–.65[a]	.49[a]	.96	3.37
Cn					.11[a]	.65[a]	6.91	2.30
Cd						.34[a]	4.82	3.13
C							5.78	2.72
B Regulating population								
Sri Lanka (n = 896)								
Years since starting fertility control	.38[a]	.00	.03	.29[a]	–.12[a]	–.07[a]	7.84	5.87
Cn – Cd		.23[a]	.60[a]	.47[a]	–.57[a]	–.03	1.35	1.96
Wants no more (= 1; others = 0)			.21[a]	.30[a]	.05	.21[a]	.86	.35
C – Cd				.39[a]	–.24[a]	.56[a]	.65	1.73
Cn					.46[a]	.69[a]	5.73	1.81
Cd						.67[a]	4.39	1.94
C							5.04	2.27
Colombia (n = 359)								
Years since starting fertility control	.40[a]	.05	.06	.41[a]	–.16[a]	–.09	10.45	5.35
Cn – Cd		.34[a]	.78[a]	.58[a]	–.74[a]	.15[a]	2.70	3.41
Wants no more (= 1; others = 0)			.29[a]	.26[a]	–.20[a]	.14[a]	.86	.35
C – Cd				.42[a]	–.60[a]	.57[a]	1.21	3.23
Cn					.12[a]	.62[a]	7.17	2.29
Cd						.32[a]	4.48	2.81
C							5.69	2.74
C Non-regulating population								
Sri Lanka (n = 715)								
Years since starting fertility control		–	–	–	–	–	0.00	0.00
Cn – Cd		.17[a]	.63[a]	.38[a]	–.59[a]	–.07	.39	1.93
Wants no more (= 1; others = 0)			.16[a]	.22[a]	.04	.15[a]	.59	.49
C – Cd				.39[a]	–.24[a]	.50[a]	.29	1.68
Cn					.53[a]	.75[a]	5.34	1.84
Cd						.72[a]	4.95	2.10
C							5.24	2.36
Colombia (n = 154)								
Years since starting fertility control		–	–	–	–	–	0.00	0.00
Cn – Cd		.36[a]	.90[a]	.38[a]	–.83[a]	.08	0.68	3.87
Wants no more (= 1; others = 0)			.46[a]	.28[a]	–.22[a]	.32[a]	0.66	0.47
C – Cd				.37[a]	–.73[a]	.35[a]	0.35	3.61
Cn					.20[a]	.78[a]	6.31	2.21
Cd						.39[a]	5.63	3.66
C							5.99	2.67

[a] Significant at .05 level or below.

NOTE: For definitions of variables, see text discussion under 'motivation' in section 4.4; a dash (–) denotes not applicable or not available in this and subsequent tables.

As expected, the relation is positive; moreover, the strength of the relation is the same for both the total and regulating populations and almost the same in the two countries. According to the usual tests, the correlations are highly significant. The percentage of the variance in duration of use of fertility control that is explained by motivation in a simple bivariate analysis is around 14 to 16 per cent.

How should one evaluate these results – do they favour or disfavour the theory of motivation advanced above? One way of answering this is by comparing the statistical results with those obtained from alternative measures of motivation. The following are the possibilities explored here and their rationale:

1 'Wants no more children'. Respondents reported on whether they did or did not want more children, or whether they were undecided. It seems reasonable to suppose that those reporting that they want no more children were consequently motivated to control their fertility unless they were secondarily sterile.
2. The difference between actual family size and desired size (C – Cd): The hypothesis is that those who have more children than are desired are more likely to limit fertility. This measure differs from Cn – Cd in that the household's actual rather than potential family size is used.
3 Desired family size (Cd): The hypothesis is that those with low desires are more likely to use control, that is, a negative association between use and desired size is anticipated.
4 Actual family size (C): The hypothesis is that the larger the actual family size, the greater will be the use of fertility control.
5 Potential surviving children (Cn): This is included for completeness, to compare with the results for C and Cd. The implicit hypothesis is that high potential family size fosters the use of fertility control.

How does the present measure of motivation (Cn – Cd) compare with these alternatives in explaining fertility control adoption? The results for the two countries are again remarkably consistent: the measure of motivation introduced in the present study, Cn – Cd, almost always performs best (see the top lines of the correlation matrices for each country in table 5). Among the other measures, although the direction of effect is always as expected, only one comes even close to Cn – Cd, that is Cn, a component of the present measure. For the total population the subjective report on wanting no more children comes in a weak third: for the regulating population, this measure has virtually no explanatory power at all. The general similarity between the two countries in the rank ordering and magnitudes of the coefficients for both the total and regulating populations is noteworthy, suggesting that in both countries the relationships within the regulating population and between the regulating and non-regulating populations are consistent. One should not assume that the pattern of correlations would always be similar among countries. For example, if one country were at a very early stage of adopting fertility control, one would expect that C – Cd and Cn – Cd would be quite similar in magnitude, and have similar correlations with use of control.

In view of the uncertainty noted above about the value of the measure of desired family size, it is of interest to observe that it uniformly bears the expected negative association with duration of use of control. Moreover, when Cd is coupled with the measure of potential family size, Cn, to obtain the theoretically preferred measure of motivation, one obtains higher correlations with use of control than with Cn or Cd alone. (The one exception to this is the regulating population in Colombia, for which the correlation of use of control with Cn is one point higher than that with Cn – Cd.)

Costs of Regulation

In general, duration of use of fertility control is expected to vary inversely with the costs of fertility control adoption. As has been noted, the measures of costs actually available, which are chiefly confined to knowledge of family planning methods and their availability, are seriously deficient relative to the ideal. One of the biggest problems with these measures is ambiguity regarding the direction of the cause-effect relation. Initially, however, this qualification will be set aside, and the data discussed on the assumption that the cause-effect relation is from greater knowledge to greater use of fertility control.

With regard to the total population, bivariate analysis shows that all the cost measures act in the expected way (table 6, panel A). Use of control varies directly with the number of methods known, with the efficiency of the methods known, with knowledge of and favourable attitudes toward abortion. Time since first use of control varies inversely with the distance from and time of travel to family planning outlets. The measure that performs best is number of methods known, which accounts for 6 per cent of the variance in Sri Lanka and 12 per cent in Colombia; efficiency of methods known comes in second, explaining 3 to 4 per cent of the variance in both countries.

The correlations between use of control and both number of methods known and efficiency of methods known are, however, largely or wholly due to differences between users and non-users, as is shown by comparison of the correlations for the regulating population with those for the total population (table 6, panels A and B). This result suggests that these measures of costs of regulation may, indeed, be showing the effects of use of control rather than vice versa. The measures relating to abortion and proximity to family planning outlets hold up a little better for the regulating population, although the correlation coefficients are as low as or lower than those for the total population. A problem with the measures relating to proximity to family planning outlets is a sharp reduction in the number of cases, chiefly due to the disproportionate number of non-responses among non-users. This suggests that this measure also may reflect the use of control rather than vice versa.

Multivariate Analysis

Despite the shortcomings of the measures of fertility control costs, it is of interest to see how the measures of motivation and costs perform when brought together in a multivariate analysis of use of control. In general, the expectation is that duration since first use will vary directly with motivation and inversely with costs of control. In order to test this hypothesis, the three motivation variables

Table 6 Correlation matrix for years since starting fertility control and specified measures of costs of regulation

Country and variable	Number of methods known	Efficiency of methods known	Abortion	Closest family planning outlet		Mean	Standard deviation
				Distance	Travel time		
A Total population							
Sri Lanka (n = 1607)							
Years since starting control	.24[a]	.18[a]	.10[a]	–	–	4.37	5.86
Number of methods known		.36[a]	.[illegible]9[a]	–	–	2.09	1.57
Efficiency of methods known[b]			.20[a]	–	–	2.87	.49
Abortion (knows = 1; other = 0)				–	–	.70	.46
Colombia (n = 504[c])							
Years since starting control	.35[a]	.19[a]	.16[a]	–.14[a]	–.19[a]	7.31	6.57
Number of methods known		.31[a]	.20[a]	–.13[a]	–.21[a]	4.46	2.45
Efficiency of methods known[b]			.12[a]	–.25[a]	–.38[a]	2.94	.32
Abortion[d]				–.08	–.07	1.08	1.27
Family planning outlet: distance in km					.67[a]	3.85	8.46
Family planning outlet: time in minutes						27.41	50.21
B Regulating population							
Sri Lanka (n = 895)							
Years since starting control	–.05	–.05	.11[a]	–	–	7.84	5.87
Number of methods known		.17[a]	.20[a]	–	–	2.65	1.53
Efficiency of methods known[b]			.11[a]	–	–	2.99	.10
Abortion (knows = 1; other = 0)				–	–	.72	.45
Colombia (n = 352[e])							
Years since starting control	.15[a]	–	.08	–.12[a]	–.16[a]	10.46	5.3[illegible]
Number of methods known		–	.07	–.11[a]	–.14[a]	5.06	2.11
Efficiency of methods known[b]			–	–	–	3.00	0.00
Abortion[d]				–.07	.01	1.21	1.25
Family planning outlet: distance in km					.61[a]	3.45	8.12
Family planning outlet: time in minutes						23.72	38.33
C Non-regulating population							
Sri Lanka (n = 712)							
Years since starting control		–	–	–	–	0.0	0.0
Number of methods known		.44[a]	.18[a]	–	–	1.38	1.31
Efficiency of methods known[b]			.26[a]	–	–	2.72	.69
Abortion (knows = 1; other = 0)				–	–	.68	.49
Colombia (n = 152[f])							
Years since starting control		–	–	–	–	0.0	0.0
Number of methods known		.37[a]	.30[a]	–.08	–.25	3.07	2.62
Efficiency of methods known[b]			.15	–.50[a]	–.52[a]	2.82	0.57
Abortion[d]				–.09	–.18	0.78	1.25
Family planning outlet: distance in km					.84[a]	5.76	9.82
Family planning outlet: time in minutes						45.43	85.95

[a] Significant at .05 level or below.
[b] Knows efficient methods = 3; only inefficient methods = 2; no methods = 1.
[c] Except family planning outlet variables, n = 300.
[d] Number of situations in which abortion is acceptable from zero to maximum of six.
[e] Except family planning outlet variables, n = 249.
[f] Except family planning outlet variables, n = 51

Table 7 Correlation coefficients between specified measures of motivation and costs of regulation (total and regulating population with two or more children)

Country and measure of motivation	Measure of costs of regulation	
	Number of methods known	Efficiency of methods known
A Total population		
Sri Lanka (n = 1607)		
Cn – Cd	.12[a]	.09[a]
Wants no more	.14[a]	.12[a]
Cn	–.09[a]	.00
Colombia (n = 504)		
Cn – Cd	.14[a]	.03
Wants no more	.02	.05
Cn	.04	.05
B Regulating population		
Sri Lanka (n = 895)		
Cn – Cd	.04	–.01
Wants no more	–.02	.00
Cn	–.17[a]	–.04
Colombia (n = 352)		
Cn – Cd	.16[a]	–
Wants no more	–.07	–
Cn	–.01	–

[a]Significant at .05 level or below.

(Cn – Cd, 'wants no more', and Cn) and two cost variables (number of methods known and efficiency of methods known) that performed best in the bivariate correlations for the total population were tried in various combinations in multivariate regressions with duration of use of control as the dependent variable. As shown in table 7, the correlations between the independent variables – the various measures of motivation and costs of regulation – are quite low. In the analysis for the regulating population, the efficient methods variable was eliminated because there was little or no variance among regulators on this measure virtually all of them knowing efficient methods (table 6).

The multivariate analyses yield little change in the principal conclusions so far obtained (tables 8 and 9). As among the motivation measures, the excess of potential over desired family size, Cn – Cd, generally performs best. The one exception is for the regulating population in Colombia, where Cn performs about equally well. With regard to costs of regulation, for the total population number of methods known performs better than efficiency of methods known, but among regulators both measures are of low or no significance and the signs of the coefficients are sometimes in the wrong direction. Perhaps the most important new conclusion is that Cn – Cd continues to perform well in explaining use of control even when put in competition with measures of fertility control costs which in the analysis for the total population may be determined by, rather than determining, the dependent variable. Moreover, Cn – Cd has greater explanatory power than the measures of fertility control costs, as the standardized coefficients show.

The metric coefficients on Cn – Cd in each country are about the same for both the total and regulating populations. Between the two countries, however, they differ; in general, the same change in motivation produces only about half as much effect on fertility control in Colombia as in Sri Lanka. However, the standardized coefficients of Cn – Cd are about the same in the two countries; the greater dispersion of this variable in Colombia than Sri Lanka (see the standard deviations in table 5) compensates for its smaller effect per unit change.

Despite differences in scope and methodology, the patterns of the bivariate and multivariate relationships reported in this section are quite similar to those of the IUSSP report (Crimmins and Easterlin 1981: tables 4–6). In the latter the population coverage is somewhat broader, the dependent fertility control variable is a simple use/non-use measure, and natural fertility (and hence potential family size) is estimated somewhat differently, as is secondary sterility. The principal departure from the present findings is that for the total population the relative performance of the 'wants no more' measure of motivation was better, although it was still inferior to Cn – Cd. Thus, when a scalar measure of fertility control is used, as here, rather than a zero/one measure, the explanatory power of a zero/one independent variable, such as 'wants no more', declines noticeably. In general, the consistency of the results between the two analyses is encouraging.

From the analysis in this section one may, perhaps, draw some tentative encouragement as to the value of the motivation measure used here. Given the roughness of the procedure for estimating potential family size at the household level and the uncertainty about the meaningfulness of responses about desired family size, especially for older (and thus higher parity) households, one might justifiably have been sceptical of the prospective value of a motivation measure obtained from differencing the two. Yet, not only does such a measure vary with use of control in the expected way, but its explanatory power surpasses plausible alternative measures of motivation, stands up in the face of competition with possibly redundant measures of fertility regulation costs, and holds about equally well for the total and regulating populations. The results with regard to the measures of fertility regulation costs are, however, more mixed.

Proximate Determinants of Motivation and Potential Family Size

The evidence shows that use of fertility control varies directly with the motivation for control, as measured by the excess of potential over desired family size, Cn – Cd, and that the latter is a better measure of motivation than a number of alternatives. But what are the respective roles of Cn and Cd in household differences in motivation – does high motivation reflect high potential family size (Cn), desires for low family size (Cd), or both? Similarly, since Cn is the product of natural fertility, N, and the child survival rate, s, to what extent are household differences in potential family size due to differences in natural fertility

Table 8 Regression of years since starting fertility control on specified measures of motivation and costs of regulation (total population with two or more children)

Regression number	Country	Motivation			Costs of regulation		Constant	Summary statistics	
		Cn − Cd	Wants no more	Cn	Number of methods known	Efficiency of methods known		$\bar{R}^2$	F
A Metric coefficient (standard error in parentheses)									
1	Sri Lanka	1.0065 (.0668)			.7610 (.0854)		1.8471	.17	171
1	Colombia	.6380 (.0598)			.7972 (.1052)		2.4115	.24	82
2	Sri Lanka		2.3567 (.3214)		.8198 (.0900)		.9072	.09	79
2	Colombia		2.8668 (.6726)		.9233 (.1105)		.9031	.15	45
3	Sri Lanka			.8076 (.0749)	.9954 (.0879)		−2.2053	.12	112
3	Colombia			.9813 (.1124)	.9005 (.1048)		−3.5135	.23	78
4	Sri Lanka	1.0368 (.0674)				1.7708 (.2770)	−1.6679	.16	149
4	Colombia	.7040 (.0716)				3.6886 (.8173)	−5.0342	.19	60
5	Sri Lanka		2.4966 (.3249)			1.8716 (.2926)	−2.8492	.07	57
5	Colombia		2.8250 (.7062)			3.7212 (.8796)	−5.9040	.06	18
6	Sri Lanka			.7333 (.0762)		2.1625 (.2874)	−5.9124	.08	74
6	Colombia			.9881 (.1184)		3.5214 (.8374)	−9.9145	.15	46
B Standardized coefficient									
1	Sri Lanka	.3437			.2033				
1	Colombia	.3580			.2970				
2	Sri Lanka		.1764		.2190				
2	Colombia		.1754		.3440				
3	Sri Lanka			.2533	.2659				
3	Colombia			.3410	.3355				
4	Sri Lanka	.3540				.1472			
4	Colombia	.3950				.1812			
5	Sri Lanka		.1868			.1556			
5	Colombia		.1729			.1828			
6	Sri Lanka			.2300		.1797			
6	Colombia			.3434		.1730			

NOTE: Number of cases: Sri Lanka 1607; Colombia 504. All coefficients are significant at .05 level or below.

Table 9 Regression of years since starting fertility control on specified measures of motivation and costs of regulation (regulating population with two or more children)

Regression number	Country	Motivation			Costs of regulation		Summary statistics	
		Cn − Cd	Wants no more	Cn	No of methods known	Constant	$\bar{R}^2$	F
A Metric coefficient (standard error in parentheses)								
1	Sri Lanka	1.1616[a]			−.2387[a]	6.9054	.15	80
		(.0926)			(.1187)			
1	Colombia	.6085[a]			.2320	7.6327	.17	36
		(.0775)			(.1258)			
2	Sri Lanka		.0139		−.1775	8.2938	.00	1
			(.5675)		(.1286)			
2	Colombia		.8659		.4002[a]	7.6972	.02	5
			(.8058)		(.1348)			
3	Sri Lanka			.9382[a]	.0146	2.4182	.08	41
				(.1052)	(.1251)			
3	Colombia			.9425[a]	.4012[a]	1.[illegible]538	.18	40
				(.1137)	(.1231)			
B Standardized coefficient								
1	Sri Lanka	.3868			−.0620			
1	Colombia	.3880			.0911			
2	Sri Lanka		.0008		−.0461			
2	Colombia		.0569		.1572			
3	Sri Lanka			.2900	.0038			
3	Colombia			.4009	.1576			

[a]Significant at .05 level or below.
NOTE: Number of cases: Sri Lanka, 896; Colombia, 352.

versus the child survival rate?

In Sri Lanka and Columbia both potential family size and desired size contribute to household differences in motivation, but the latter plays a somewhat larger role. This can be seen from the following correlation coefficients, taken from table 5:

	Total population		Regulating population		Non-regulating population	
	Cn−Cd with Cn	Cn−Cd with Cd	Cn−Cd with Cn	Cn−Cd with Cd	Cn−Cd with Cn	Cn−Cd with Cd
Sri Lanka	.44	−.59	.47	−.57	.38	−.59
Colombia	.53	−.78	.58	−.74	.38	−.83

Though the correlations are generally somewhat higher in Colombia than Sri Lanka, in both countries the correlation of Cn − Cd with Cd is uniformly higher than that with Cn. Within each country the results for the two component population groups are fairly similar.

With regard to the proximate sources of household differences in family size, Cn, the role of natural fertility is more important, though differences in survival rates also play a part. The correlation coefficients are:

	Total population		Regulating population		Non-regulating population	
	Cn with N	Cn with s	Cn with N	Cn with s	Cn with N	Cn with s
Sri Lanka	.86	.31	.88	.22	.83	.38
Colombia	.80	.32	.83	.27	.73	.36

In this case the results are about the same both between countries and between population groups.

One must be careful not to assume that these results, based on data for one point of time, necessarily apply to changes over time. For example, in a given country the distribution of households by potential family size might shift upward over time as a result of improvements in child survival common to all households, while the distribution of households by desired size remained constant. The cross-section associations of motivation with Cn and Cd observed at any point in time might be of the kind found here, even though the increase in motivation over time was entirely due to potential family size.

Table 10 Mean and standard deviation of actual unwanted children (C − Cd) of non-regulators, and of actual unwanted children (C − Cd), potential unwanted children (Cn − Cd), and 'children averted' (Cn − C) of regulators (population with two or more children)

Country	Non-regulators	Regulators		
	C − Cd	C − Cd	Cn − Cd	Cn − C
A Sri Lanka				
Mean	.29	.65	1.35	.70
Standard deviation	1.68	1.73	1.95	1.67
Number of cases	715	904	904	904
B Colombia				
Mean	.35	1.21	2.70	1.51
Standard deviation	3.61	3.23	3.41	2.27
Number of cases	154	359	359	361

Births Averted and Unwanted Fertility

The framework used here lends itself not only to extending the analysis back into the sources of motivation, but also forward into the effects of the use of fertility control in terms of births averted and of non-use in terms of unwanted fertility.

The excess of a household's actual number of living children over its desired family size is the implied number of unwanted children it has. In both countries both regulators and non-regulators have, on average, more children than they want but the excess is greater for regulators, despite their deliberate restriction of fertility (table 10, columns 1 and 2). However, if regulators, like non-regulators, had not controlled their fertility at all, the number of unwanted children they would have had – the excess of potential over desired size, Cn − Cd would have been considerably greater (table 10, column 3). The success of their efforts at fertility control is given by the excess of potential over actual family size – what one might think of as the number of 'children averted'. In both countries the number of children averted by regulators through fertility control is somewhat greater than the number of unwanted children they actually ended up with; in effect, fertility control reduced the number of prospective unwanted children by more than half (table 10, columns 2 and 4).

The concept of 'children averted' can be converted to the familiar 'births averted' measure by dividing it by the child survival rate (the complement of the child mortality rate in table 4). When this is done, one finds that the mean number of births averted by regulators is .74 in Sri Lanka and 1.65 in Colombia. (Alternatively, births averted can be derived from table 3 by differencing the regulators' values of estimated natural fertility and children ever born.)

5 Third Stage: Analysis of Determinants of Desired Family Size, Potential Family Size and Costs of Regulation

Use of fertility control is related directly to the degree of motivation, as measured by the excess of potential over desired family size, Cn − Cd, and, for the total population, inversely related to the costs of fertility regulation, as measured by the number of methods known. But what are the determinants of the independent variables in the analysis of fertility control? To explore this question, the third-stage analysis examines the relation of various social, economic and cultural conditions to the costs of fertility control, RC, and the two components of motivation, Cd and Cn.

As has been seen, potential family size, Cn, is the product of the child survival rate, s, and natural fertility, N. The latter, in turn, is shaped by the 'intervening variables' other than fertility control in table 2. These variables include marriage duration, first and second birth interval, secondary sterility, duration of breastfeeding, pregnancy wastage and child mortality. Since s is also determined by one of these variables (it is the complement of child mortality), these variables are termed collectively here 'determinants of Cn'. Obviously, an analysis of the determinants of Cn can alternatively be viewed as an analysis of the determinants of the intervening variables other than fertility control. Hence, in the third-stage analysis the dependent variables become the independent variables of the first two stages.

In the initial phase of the third-stage analysis the independent variables consist of virtually the entire set of standard background variables in the WFS core questionnaire. Analytically, they fall into two groups: one is a set of 'modernization variables', reflecting processes of socio-economic development common to different countries (expanding education, urbanization, occupational shifts and changing female roles); the other is a set of 'cultural variables', reflecting conditions peculiar to each country. In the first set the specific variables were education of both husband and wife, husband's occupation, wife's work status and occupation before and after marriage, and rural/urban residence, distinguishing within the urban category migrants from rural areas. In the second set, the variables were ethnicity and religion in Sri Lanka, and region and type of marital union (common law or other) in Colombia.

Regressions of each of the dependent variables against the independent variables (with the latter taken both individually and in various combinations) revealed that several of the core variables had little or no significant effect on any of the dependent variables, or were dominated by other variables. This was true of husband's education (which was almost always dominated by wife's education), place of origin for urban residents, variables relating to wife's work status and occupation after marriage, religion in Sri Lanka (which was dominated by ethnicity) and type of marital union in Colombia. Experimentation with various occupational groupings led to a fairly aggregative classification.

The results presented here are a distillation of the initial analysis and comprise the regression of each of the dependent variables on the remaining core variables. The same independent variables are used in all regressions, even though some prove to be not significant, for purposes of comparison between countries and among the dependent variables. The modernization variables included here are wife's education, rural/urban residence, occupational structure (divided primarily along agricultural/non-agricultural lines), and wife's work status before marriage; the cultural variables included are ethnicity in Sri Lanka and region in Colombia. All of these variables are fully defined in table A3. Their means, standard deviations, and correlations with each other and with each of the dependent variables are given in tables 11 and 12.

In both countries the dependent variables fall into two groups, based on the $\bar{R}^2$ values and number of significant relationships in the regressions (tables 13 and 14). For one group, comprising four determinants of natural fertility (first and second birth interval, secondary sterility and pregnancy wastage), the proportion of variance explained by socio-economic and cultural conditions is low or negligible (around 2 per cent or less) and the independent variables are almost uniformly not significant. For these dependent variables it seems likely that differences among households are due primarily to genetic or physiological factors rather than socio-economic and cultural conditions. Of course, behavioural variables other than those included in the WFS core questionnaire might be significantly related to one or more of these dependent variables.

For the second group of dependent variables, some socio-economic and cultural variables are significant and the proportion of total variance explained is higher, ranging from 4 to 31 per cent. These variables include desired family size, number of fertility control methods known, duration of marriage, duration of breastfeeding and child mortality. In terms of consistency between the two countries, the $\bar{R}^2$ values for these variables are fairly similar except for duration of marriage and duration of breast-feeding.

Considering all of the regressions together, one finds that the number of significant relationships is smaller in Colombia than Sri Lanka, perhaps in part because of the considerably smaller sample size there. It is noteworthy that among the modernization variables other than wife's farm work before marriage, all of the significant relationships in Colombia also hold in Sri Lanka, and in the same direction.

As a group, the modernization variables consistently dominate the cultural variables; when the latter are dropped out of the regressions, the proportion of variance explained declines only slightly. To the extent that one is interested in the implications of the analysis for changes over time, this result is encouraging, because the modernization variables change relatively rapidly compared with the cultural ones.

Table 11 Mean, standard deviation, and correlation matrix for variables in third-stage analysis: Sri Lanka (population with two or more children)

Variable	Wife's education	Rural residence	Farmer (husband)	Agricul-tural worker (husband)	Unskilled labourer (husband)	Farm work before marriage (wife)	Non-farm work before marriage (wife)	Sri Lanka Tamil	Indian Tamil	Sri Lanka Moor	Mean	Standard deviation
A Dependent variables												
Desired family size, Cd	−.30[a]	.15[a]	.15[a]	.03	.03	.05	−.21[a]	.04	−.02	.11[a]	4.65	2.05
Number of methods, RC	.40[a]	−.18[a]	−.18[a]	−.14[a]	−.06[a]	−.14[a]	.28[a]	−.07[a]	−.06[a]	−.04	2.09	1.57
Duration of marriage	−.50[a]	.13[a]	.18[a]	.15[a]	.05	.16[a]	−.38[a]	.09[a]	.13[a]	.11[a]	19.81	5.63
Months breastfeeding	−.17[a]	.12[a]	.07[a]	.08[a]	.04	.10[a]	−.12[a]	−.04	.01	−.01	16.80	12.64
First birth interval	−.07[a]	.00	.02	.05	.04	.04	−.05	.05	.06[a]	.04	21.51	19.19
Second birth interval	−.05	−.04	−.03	.06[a]	.00	.05	−.03	.06[a]	.06[a]	−.02	29.49	20.54
Not secondarily sterile	.14[a]	−.01	.02	−.06[a]	−.04	−.04	.08[a]	−.08[a]	−.06[a]	−.04	.67	.47
Proportion of pregnancy wastage	.02	−.01	−.01	.03	−.03	.07[a]	.01	.00	.04	−.04	.06	.12
Proportion of child mortality	−.19[a]	.05	.02	.14[a]	.02	.15[a]	−.09[a]	.04	.16[a]	.02	.09	.15
B Independent variables												
Wife's education		−.24	−.19[a]	−.27[a]	−.14[a]	−.37[a]	.33[a]	.05	−.26[a]	−.10[a]	4.36	3.51
Rural residence			.24[a]	.16[a]	−.06[a]	.22[a]	−.12[a]	−.11[a]	.11[a]	−.11[a]	.83	.38
Farmer (husband)				−.26[a]	−.21[a]	.15[a]	−.14[a]	−.04	−.11[a]	−.03	.29	.45
Agricultural worker (husband)					−.14[a]	.31[a]	−.15[a]	.02	.43[a]	−.04	.14	.35
Unskilled labourer (husband)						−.10[a]	−.02	.04	−.08[a]	.02	.10	.30
Farm work before marriage (wife)							−.22[a]	−.10[a]	.49[a]	−.11[a]	.20	.40
Non-farm work before marriage (wife)								−.09[a]	−.12[a]	−.06[a]	.16	.37
Sri Lanka Tamil									−.11[a]	−.08[a]	.12	.32
Indian Tamil										−.07[a]	.08	.27
Sri Lanka Moor											.05	.21

[a]Significant at .05 level or below.
NOTE: Number of cases: for dependent variables, see table 13, line 12; for independent variables, 1637.

Table 12 Mean, standard deviation, and correlation matrix for variables in third-stage analysis: Colombia (population with two or more children)

Variable	Wife's education	Rural residence	Farmer (husband)	Agricultural worker (husband)	Service worker (husband)	Farm work before marriage (wife)	Non-farm work before marriage (wife)	Region: Atlantic	Oriental	Central	Bogotá	Mean	Standard deviation
A Dependent variables													
Desired family size, Cd	−.19[a,b]	.16[a]	.08	.12[a]	−.12[a]	.18[a]	−.17[a]	.15[a]	.06	.02	−.16[a]	4.80	3.09
Number of methods, RC	.32[a]	−.34[a]	−.19[a]	−.19[a]	.12[a]	−.09[a]	.16[a]	.06	−.10[a]	−.02	.16[a]	4.45	2.46
Duration of marriage	−.22[a]	.15[a]	.09[a]	.12[a]	−.08	.06	−.24[a]	.12[a]	.00	−.03	−.05	19.37	5.18
Months breastfeeding	−.26[a]	.24[a]	.11[a]	.19[a]	−.08	.15[a]	−.09[a]	.19[a]	.08	−.16[a]	−.06	8.37	7.33
First birth interval	−.12[a]	.06	.02	.08	−.01	.08	−.01	.10[a]	−.01	−.10[a]	.00	16.71	13.67
Second birth interval	−.07	.04	.04	.03	−.02	.00	−.04	.05	.00	−.11[a]	.03	23.79	16.55
Not secondarily sterile	.10[a]	.02	−.03	.02	−.06	.01	.04	−.05	−.01	.06	.01	.78	.42
Proportion of pregnancy wastage	.12[a]	−.09[a]	−.05	−.05	.05	−.03	.01	−.01	−.06	.14[a]	−.03	.07	.12
Proportion of child mortality	−.28[a]	.20[a]	.04	.20[a]	−.09[a]	.17[a]	−.06	−.04	−.01	.06	−.08	.11	.17
B Independent variables													
Wife's education		−.41[a]	−.18[a]	−.32[a]	.00	−.19[a]	.19[a]	−.10[a]	−.12[a]	.05	.24[a]	3.70	3.09
Rural residence			.38[a]	.54[a]	−.45[a]	.25[a]	−.30[a]	.07	.11[a]	.07	−.31[a]	.33	.47
Farmer (husband)				−.21[a]	−.31[a]	.11[a]	−.17[a]	.08	.04	.06	−.17[a]	.13	.33
Agricultural worker (husband)					−.46[a]	.13[a]	−.20[a]	.07	.02	.07	−.23[a]	.24	.43
Service worker (husband)						−.11[a]	.21[a]	−.09[a]	.01	−.08	.16[a]	.40	.49
Farm work before (marriage (wife)							−.20[a]	−.04	−.04	.03	−.07	.05	.21
Non-farm work before marriage (wife)								−.05	−.01	−.11[a]	.20[a]	.46	.50
Atlantic region									−.21[a]	−.29[a]	−.19[a]	.15	.36
Oriental region										−.33[a]	−.22[a]	.19	.39
Central region											−.30[a]	.32	.47
Bogotá region												.17	.37

[a] Significant at .05 level or below.
[b] Husband's education.
NOTE: Number of cases: for dependent variables, see table 14, line 13; for independent variables, 523.

Table 13 Regressions of desired family size, costs of regulation, and determinants of potential family size on modernization and cultural variables: Sri Lanka (population with two or more children)

Variable	Desired family size, Cd	Number of methods known, RC	Determinants of potential family size, Cn						
			Duration of marriage	Months breast-feeding	First birth interval	Second birth interval	Not secondarily sterile	Proportion of pregnancy wastage	Proportion of child mortality
A Metric coefficient (standard error in parentheses)									
Modernization variables									
1 Wife's education	−.1573[a]	.1414[a]	−.6471[a]	−.4015[a]	−.1678	−.2733	.0178[a]	.0011	−.0054[a]
	(.0166)	(.0121)	(.0403)	(.1070)	(.1670)	(.1886)	(.0040)	(.0010)	(.0012)
2 Rural residence	.5067[a]	−.2945[a]	.0566	1.8967[a]	−.8573	−2.9906	.0035	−.0057	−.0012
	(.1356)	(.0992)	(.3305)	(.8763)	(1.3720)	(1.5513)	(.0328)	(.0083)	(.0100)
3 Farmer (husband)	.2916[a]	−.4059[a]	1.3105[a]	1.0962	1.6478	−1.0282	.0361	−.0023	.0075
	(.1258)	(.0922)	(.3068)	(.8155)	(1.2744)	(1.4377)	(.0305)	(.0077)	(.0093)
4 Agricultural worker (husband)	−.0855	−.3684[a]	.6903	2.4660[a]	1.8755	1.4389	−.0005	.0024	.0261[a]
	(.1688	(.1236)	(.4118)	(1.0920)	(1.7091)	(1.8795)	(.0409)	(.0103)	(.0125)
5 Unskilled labourer (husband)	−.0534	−.2189	.2030	2.0154	3.1448	−.5796	−.0196	−.0073	.0108
	(.1711)	(.1256)	(.4173)	(1.1064)	(1.7206)	(1.9056)	(.0415)	(.0104)	(.0127)
6 Farm work before marriage (wife)	−.2359	.1467	−.8561[a]	1.2926	.3002	1.1515	.0138	.0238[a]	.0177
	(.1480)	(.1083)	(.3609)	(.9569)	(1.4900)	(1.6764)	(.0359)	(.0090)	(.0110)
7 Non-farm work before marriage (wife)	−.6109[a]	.6132[a]	−3.3547[a]	−2.2533[a]	−.6853	−.8012	.0322	.0031	−.0027
	(.1395)	(.1021)	(.3401)	(.9033)	(1.4136)	(1.6685)	(.0338)	(.0085)	(.0103)
Cultural variables									
8 Sri Lanka Tamil	.3388[a]	−.3585[a]	1.6078[a]	−1.5799	3.3836[a]	3.4816[a]	−.1304[a]	−.0004	.0270[a]
	(.1505)	(.1101)	(.3670)	(.9730)	(1.5122)	(1.6612)	(.0365)	(.0092)	(.0111)
9 Indian Tamil	−.5436[a]	.2264	.6571	−3.5442[a]	3.7701	2.0130	−.0716	.0018	.0456[a]
	(.2161)	(.1582)	(.5271)	(1.3974)	(2.1795)	(2.3855)	(.0524)	(.0132)	(.0160)
10 Sri Lanka Moor	.7598[a]	−.0594	1.5648[a]	−1.2224	4.1287	−2.1542	−.0623	−.0174	.0147
	(.2310)	(.1691)	(.5634)	(1.4935)	(2.3541)	(2.5511)	(.0560)	(.0141)	(.0171)
11 Constant	4.9646	1.8029	22.4815	16.7434	21.0724	32.5987	.5989	.0522	.0944
B Summary statistics									
12 Number of cases	1634	1633	1637	1635	1593	1445	1637	1637	1637
13 $\bar{R}^2$	.133	.208	.314	.043	.009	.007	.027	.003	.053
14 $\bar{R}^2$ excluding lines 8–10	.122	.203	.304	.040	.005	.004	.020	.004	.047
15 F	26	44	76	8	2	2	5	1	10

[a]Significant at .05 level or below.

Table 14 Regressions of desired family size, costs of regulation, and determinants of potential family size on modernization and cultural variables: Colombia (population with two or more children)

Variable	Desired family size, Cd	Number of methods known, RC	Determinants of potential family size, Cn						
			Duration of marriage	Months breast-feeding	First birth interval	Second birth interval	Not secondarily sterile	Proportion of pregnancy wastage	Proportion of child mortality
A Metric coefficient (standard error in parentheses)									
Modernization variables									
1 Wife's education	−.1412[a,b]	.1578[a]	−.2808[a]	−.3032[a]	−.3619	−.3096	.0146[a]	.0040	−.0129[a]
	(.0477)	(.0394)	(.0859)	(.1182)	(.2502)	(.3347)	(.0072)	(.0021)	(.0028)
2 Rural residence	−.1491	−.9730[a]	−.1864	1.0506	−.5043	−.7249	.0597	−.0101	.0087
	(.4240)	(.3257)	(.7112)	(.9860)	(1.9569)	(2.4342)	(.0597)	(.0172)	(.0231)
3 Farmer (husband)	−.3118	−.7238	.6804	2.2893	2.3645	3.7577	−.0683	−.0087	.0032
	(.5730)	(.4423)	(.9585)	(1.3300)	(2.6449)	(3.3862)	(.0804)	(.0231)	(.0312)
4 Agricultural worker (husband)	−.2823	−.2903	.6370	2.8430[a]	3.1947	2.6076	−.0117	−.0001	.0408
	(.5212)	(.3928)	(.8579)	(1.1829)	(2.3753)	(3.0743)	(.0720)	(.0207)	(.0279)
5 Service worker (husband)	−.6245	−.0810	−.1192	1.0746	1.5158	.8904	−.0535	.0112	−.0104
	(.3766)	(.2813)	(.6128)	(.8439)	(1.7060)	(2.2726)	(.0514)	(.0148)	(.0199)
6 Farm work before marriage (wife)	2.2692[a]	.3747	−.4103	3.7379[a]	4.3406	−1.6769	.0430	.0019	.0854[a]
	(.6494)	(.5003)	(1.0974)	(1.5354)	(3.0068)	(3.7451)	(.0921)	(.0265)	(.0357)
7 Non-farm work before marriage (wife)	−.5765[a]	.2100	−2.1009[a]	−.0605	.4689	−1.2267	.0444	−.0013	.0149
	(.2786)	(.2158)	(.4696)	(.6467)	(1.3058)	(1.6943)	(.0394)	(.0113)	(.0153)
Cultural variables									
8 Atlantic	1.6967[a]	1.0091[a]	1.4038	3.5313[a]	2.4290	−.6714	−.0230	.0194	−.0296
	(.4568)	(.3515)	(.7676)	(1.0574)	(2.1254)	(2.7387)	(.0644)	(.0185)	(.0250)
9 Oriental	1.0029[a]	.1733	.0896	1.4739	−.7750	−2.1856	.0164	.0051	−.0143
	(.4322)	(.3312)	(.7272)	(1.0041)	(2.0246)	(2.6052)	(.0610)	(.0176).	(.0236)
10 Central	.6838	.4208	.0236	−1.2099	−2.3426	−4.8207[a]	.0486	.0413[a]	.0140
	(.3877)	(.3004)	(.6551)	(.9035)	(1.8131)	(2.3704)	(.0550)	(.0158)	(.0213)
11 Bogotá	.0315	.5730	.9358	1.4132	1.1716	.6964	.0063	−.0062	.0045
	(.4610)	(.3603)	(.7759)	(1.0713)	(2.1771)	(2.8603)	(.0651)	(.0187)	(.0252)
12 Constant	5.2716	3.8530	20.8596	6.9298	16.3704	26.0534	.6973	.0417	.1407
B Summary statistics									
13 Number of cases	521	514	523	520	503	451	523	523	523
14 $\bar{R}^2$	.095	.156	.082	.133	.015	.000	.003	.019	.094
15 $\bar{R}^2$ excluding lines 8–11	.070	.146	.078	.090	.008	−.008	.007	.004	.094
16 F	6	10	5	8	2	1	1	2	6

[a] Significant at .05 level or below.
[b] Husband's years of education substituted for wife's education.

Among the modernization variables, wife's education is by far the most consistently significant. The initial phase of the analysis also showed that wife's education was consistently more important than husband's education, with the one exception of desired family size in Colombia. (When wife's and husband's education were included together in the regression equations, they usually eliminated each other from significance.)

Next in importance is wife's non-farm work experience before marriage. For some of the relationships with this variable, however, the true cause-effect direction is open to question. For example, if a woman is unable to marry young, then the probability of her working before marriage and reducing her desired family size is increased. In this case, the causal variable is her marital situation, and work status and family size desires are effects.

A similar question regarding cause-effect directions might be raised about the negative relationship between wife's education and duration of marriage; if a woman marries later (ie has shorter marital duration) is she not likely to stay in school longer? In both countries, however, most women finish school long before they are married. For example, if in order to estimate mean age at completion of school the mean value for wife's years of education (tables 11 and 12) is added to 6.0, then women's schooling in Sri Lanka is completed, on the average, at 10.4 years; in Colombia at 9.7 years. These values compare with mean ages at marriage of 19.1 and 19.7 years respectively.

The other modernization variables that are occasionally significant are almost all linked to two processes that are partly associated: the shift from rural to urban residence and from agricultural to non-agricultural occupations. These variables include, specifically, rural residence, the occupational categories of farmer and agricultural worker, and wife's farm work before marriage, all of which would be expected to decline as modernization progresses.

Among the cultural variables, perhaps the most surprising result is found is Sri Lanka, where the ethnic group Sri Lanka Tamil turns out to be significantly different from the dominant Sinhalese group considerably more often than are Indian Tamils. Although both Sri Lankan and Indian Tamils are overwhelmingly Hindu, whereas the Sinhalese are chiefly Buddhist, the Sri Lanka Tamils share with the Sinhalese a Sri Lankan schooling experience, whereas the Indian Tamils do not.

The results for the individual dependent variables are generally consistent with those commonly observed. In both countries family size desires are negatively associated with wife's education and non-farm work before marriage (though for the latter variable some reservation has been noted about the causal relation). Also, in Sri Lanka family size desires are positively associated with rural residence and farm proprietorship; in Colombia, with wife's farm work before marriage.

In both countries knowledge of fertility control, as measured by number of methods known, is directly related to wife's education and inversely to rural residence. In Sri Lanka knowledge is also positively associated with wife's non-farm work before marriage, and inversely with farm work for the husband, either as proprietor or labourer.

In both Sri Lanka and Colombia marriages tend to be longer for wives with less education and no non-farm work experience before marriage (although again the caution regarding the causal effect of the non-farm work variable is applicable). Also in Sri Lanka, longer marital duration is associated positively with farm proprietorship and negatively with wife's farm work before marriage.

Duration of breastfeeding is longer for women with less education or whose husbands are agricultural labourers. In Sri Lanka women with rural residence tend to breastfeed longer, while those with non-farm work experience before marriage breastfeed less. In Colombia, wife's farm work experience before marriage is positively associated with duration of breastfeeding.

In both countries child mortality is higher among women with less education. Also, in Sri Lanka it is higher among women whose husbands are agricultural workers, and in Colombia among wives who did farm work before marriage.

As has been mentioned, modernization would usually be accompanied by rising education, declines in rural residence and agricultural occupations, and an increase in women's non-farm work before marriage. The present results for the dependent variables that are sensitive to modernization processes – family size desires, number of methods known, marriage duration, length of breastfeeding and child mortality – indicate that the effects of these changes, when significant, are mutually reinforcing. In other words, each of the modernization processes works in the same direction on a given dependent variable. Moreover, the direction of effect (negative) is the same for all of the dependent variables except number of methods known.

6 Integrating the Stages: the Impact of Modernization on Fertility

This section aims to illustrate how the three stages fit together analytically to link modernization to fertility. Because this is an exploratory report and further testing and refinement both of measures and of the analysis at each stage are needed, the specific empirical results are, at best, extremely tentative. It is the clarification of the analytical links between the stages that is of primary interest.

Education is the aspect of modernization chosen for the illustration. The aim is to trace the ways in which ten years' difference in education between two groups of wives would affect their cumulative fertility by ages 35–44, all other factors remaining constant.

The first step is to estimate the impact of the postulated difference in education on natural fertility. The third-stage analysis indicated that education had significant effects on four determinants of natural fertility: duration of marriage, secondary sterility, length of breastfeeding and child mortality (tables 13 and 14). Multiplying the ten years' difference in education by the regression coefficient of each of these intervening variables on education, one obtains the implied difference in the variables due to education (table 15, columns 1–3). For example, in Sri Lanka the more educated group would be expected to have a marriage duration about 6.5 years less than the less educated group; in Colombia, about 2.8 years less (lines 1 and 7).

The regression coefficient of children ever born on each of these intervening variables obtained in the first-stage analysis (table 2) enables one to convert the estimated difference in the intervening variable to an estimated difference in fertility (table 15, columns 3–5). Thus, shorter marriage duration for the more educated group would result in Sri Lanka in about 2.1 fewer births; in Colombia, about 1.3 fewer births.

In contrast, the effect of increased education on fertility within marriage is slightly positive. This is seen by comparing the effects of education on the intervening variables other than duration of marriage: in both countries positive contributions from lower secondary sterility and shorter breastfeeding outweigh a negative contribution from reduced child mortality (table 15, column 5, lines 2–5 and 8–11). Overall, the effect of increased education through shorter marital duration predominates, so that natural fertility among more educated women is lower than among less educated, by about 1.7 births in Sri Lanka and 1.2 births in Colombia (lines 6 and 12).

The results of table 15 can also be used to estimate the effect of differences in education on potential family size, Cn. Analytically, the basis for the estimate is given by:

$$\Delta Cn = \Delta s \cdot \bar{N} - \Delta N \cdot \bar{s} + \Delta s \cdot \Delta N$$

where Δ refers to differences between the more and less educated group on the indicated variable, $\bar{N}$ is mean natural fertility, and $\bar{s}$ is the mean child survival rate.

In both countries the effects of education on potential family size are the same in direction but differ somewhat in magnitude (table 16). The higher child survival rate of the more educated group tends to raise potential family size, the lower natural fertility rate, to lower it; and the effect of the latter predominates over the former (lines 3 and 6). On balance, increased education tends to reduce potential family size, though the estimated effect is much smaller in Colombia than Sri Lanka – 0.2 compared to 1.3 surviving children.

The implications of the postulated difference in education for the use of fertility control can be found by bringing the second-stage analysis into the picture. For this purpose, in addition to the effect of education on potential family size, that on desired family size and costs of regulation is also needed. Following the same lines of analysis as for the natural fertility variables in table 15, one finds that in both countries ten years more schooling is accompanied by a reduction in desired family size of around 1.5 children, and an increase of about 1.5 in the number of fertility control methods known (table 17, column 3, lines 2 and 4, 7 and 9). The combined effect of the differences in desired family size and potential family size is to increase the motivation for fertility control (Cn – Cd) in both countries, though more so in Colombia than Sri Lanka (column 3, lines 3 and 8). This estimated difference in motivation together with that in costs of regulation can be transformed into differences in duration of fertility control use by means of the regression coefficients obtained in the second-stage analysis (columns 4 and 5). Overall, ten years more schooling is estimated to result in about 1.3 more years use of fertility control in Sri Lanka and 2.0 more years use in Colombia (column 5, lines 5 and 10).

Previously, the results showed that education tends to reduce natural fertility, because the negative effect of education on marriage duration outweighs its positive effect on fertility within marriage. It is now possible to take account also of the effect of education on fertility arising from fertility regulation by using the regression coefficient of children ever born on fertility control obtained in the intervening variables analysis of table 2. When this is done, one finds that the increased duration of fertility control use among the more educated group of women reduces their relative fertility by about 0.1 births in Sri Lanka and 0.4 births in Colombia (table 18, panel A). The overall effect on fertility of ten years' difference in education, including effects through both natural fertility and fertility control, turns out to be similar in both countries: somewhat less than two births (table 18, line 9). In Sri Lanka, however, all of the reduction is due to the effect

Table 15 Estimated difference in natural fertility due to effect of ten years' difference in education on specified intervening variables

Country and variable	(1) Difference in years of education	(2) Regression coefficient of specified variable on education (tables 13 and 14)	(3) Difference in specified variable due to difference in education (col. 1 X col. 2)	(4) Regression coefficient of children ever born on specified variable (table 2)	(5) Difference in children ever born due to effect of education on specified variable (col. 3 X col. 4)
A Sri Lanka					
1 Duration of marriage, years	10	–.6471	–6.471	.3169	–2.051
2 Proportion not secondarily sterile	10	.0178	0.178	1.8082	.322
3 Months breastfeeding	10	–.4015	–4.015	–.0160	.064
4 Proportion of child mortality	10	–.0054	–0.054	.9819	–.053
5 Difference in natural marital fertility (sum of lines 2–4)	–	–	–	–	.333
6 Difference in total natural fertility (sum of lines 1–4)	–	–	–	–	–1.718
B Colombia					
7 Duration of marriage, years	10	–.2808	–2.808	.4482	–1.259
8 Proportion not secondarily sterile	10	.0146	0.146	2.5842	.377
9 Months breastfeeding	10	–.3032	–3.032	–.0343	.104
10 Proportion of child mortality	10	–.0129	–0.129	3.0852	–.398
11 Difference in natural marital fertility (sum of lines 8–10)	–	–	–	–	.083
12 Difference in total natural fertility (sum of lines 7–10)	–	–	–	–	–1.176

NOTE: Differences are calculated as excess of more educated over less educated.

Table 16 Estimated difference in potential family size, Cn, due to effect of ten years' difference in education on child survival rate and natural fertility

Variable	Sri Lanka	Colombia
1 Difference in proportion of children surviving (table 15, column 3, sign reversed)	.054	.129
2 Mean natural fertility (table 3, weighted average)	6.15	7.90
3 Effect on potential family size of difference in survival rate (line 1 X line 2)	.33	1.02
4 Difference in natural fertility (table 15, lines 6 and 12)	–1.72	–1.18
5 Mean child survival rate (table 1, complement of proportion of child mortality)	.91	.89
6 Effect on potential family size of difference in natural fertility (line 4 X line 5)	–1.57	–1.05
7 Effect on potential family size of interaction effect (line 1 X line 4)	–.09	–.15
8 Difference in potential family size, Cn, due to all sources (sum of lines 3, 6 and 7)	–1.33	–.18

NOTE: Differences are calculated as excess of more educated over less educated.

of education on marriage duration, whereas in Colombia fertility limitation within marriage makes some contribution (lines 7 and 8).

To sum up, this analysis has illustrated the ways in which differential education is linked to differential fertility. The empirical results indicate that education tends to raise natural fertility within marriage, because positive effects through reduced secondary sterility and breastfeeding tend to outweigh a negative effect from reduced child mortality. The positive effect of education on natural marital fertility, however, is considerably outweighed by its negative impact on duration of marriage, yielding reduced natural fertility overall among the more educated. When, in addition, the effect of education on fertility control is

Table 17 Estimated difference in duration of fertility control due to effect of ten years' difference in education on potential family size, desired family size, and costs of regulation

Country and variable	(1) Difference in years of education	(2) Regression coefficient of specified variable on education (tables 13 and 14)	(3) Difference in specified variable due to difference in education	(4) Regression coefficient of fertility control on specified variable (table 8)	(5) Difference in duration of fertility control due to effect of education on specified variable (column 3 X column 4)
A Sri Lanka					
1 Potential family size, Cn (table 16)	–	–	−1.330	–	–
2 Desired family size, Cd	10	−.1573	−1.573[a]	–	–
3 Motivation, Cn − Cd (line 1 minus line 2)	–	–	.243	1.0065	.244
4 Costs of regulation, RC	10	.1414	1.414[a]	.7610	1.076
5 Difference in duration of fertility control (sum of lines 3 and 4)	–	–	–	–	1.320
B Colombia					
6 Potential family size, Cn (table 16)	–	–	−.180	–	–
7 Desired family size, Cd	10	−.1412	−1.412[a]	–	–
8 Motivation, Cn − Cd (line 6 minus line 7)	–	–	1.232	.6380	.786
9 Costs of regulation, RC	10	.1578	1.578[a]	.7972	1.258
10 Difference in duration of fertility control (sum of lines 8 and 9)	–	–	–	–	2.044

[a]Column 1 X column 2.
NOTE: Differences are calculated as excess of more over less educated.

Table 18 Estimated difference in children ever born due to effect of ten years' difference in education on duration of fertility control and natural fertility

Variable	Sri Lanka	Colombia
A Difference in children ever born due to fertility control		
1 Difference in duration of fertility control (table 17)	1.320	2.044
2 Regression coefficient of children ever born on duration of fertility control (table 2)	−.108	−.173
3 Difference in children ever born due to fertility control (line 1 X line 2)	−.14	−.35
B Difference in children ever born due to natural fertility (table 15)		
4 Due to natural marital fertility	.33	.08
5 Due to duration of marriage	−2.05	−1.26
6 Due to total natural fertility	−1.72	−1.18
C Difference in children ever born due to all sources		
7 Due to marital fertility (sum of lines 3 and 4)	.19	−.27
8 Due to duration of marriage (line 5)	−2.05	−1.26
9 Due to all sources (sum of lines 7 and 8)	−1.86	−1.53

NOTE: Differences are calculated as excess of more over less educated.

considered, fertility is even further reduced. Education stimulates greater fertility control by increasing knowledge of methods of control and raising the motivation for control. Increased motivation occurs because the effect of education in reducing family size outweighs its effect in lowering potential family size.

The results of this analysis can be compared with those found by regressing the dependent variable of stage one, children ever born, directly on the set of independent variables of stage three. When this is done, one obtains for the two countries almost identical significant regression coefficients on years of education: −.2510 in Sri Lanka and −.2451 in Colombia. The effect of ten years' difference in education implied by the direct regression, about 2.5 fewer births among the more educated in each country, is somewhat higher than the 1.9 and 1.5 fewer births obtained above by integrating the three-stage analysis.

The value of the three-stage analysis compared with direct regression is that it clarifies the number and variety of the mechanisms through which education operates. Comparison of direct regressions of fertility on education for a number of countries reveals wide variation in the regression coefficient, not only with regard to magnitude, but even sign (see Cochrane, forthcoming). The numerous links between fertility and education brought out in the present analysis make clear why such variation might occur. Moreover, if one's interest is not just in how education is linked to fertility, but how modernization in its numerous aspects affects fertility, then the value of an analysis of the present type is even more manifest.

At the same time, it should be recognized that the present analysis is itself far from exhaustive. To take education as an example once again, even if the present empirical findings are accepted, there remain questions of why and how education influences age at marriage, breastfeeding, desired family size and the other variables significantly related to it. To investigate this, however, requires a very different body of data.

7 Conclusion

This paper has sought to test and implement empirically the theoretical view embodied in the synthesis framework of fertility determination using WFS data for two countries, Sri Lanka and Colombia. The analysis proceeds in three stages, with multiple regressions fitted to household data by the ordinary least squares technique at each stage. In the first stage, observed fertility is linked to use of fertility control and other intervening variables through a proximate determinants framework modelled along lines commonly found in the literature. In the second stage, use of fertility control is analysed in relation to the motivation for control, which is taken to vary with the excess of potential over desired family size and the costs of fertility regulation. In the third stage, the independent variables of stages one and two are linked to socio-economic and cultural conditions. The connections between the stages are illustrated by tracing the various mechanisms through which one of the socio-economic determinants, education, affects observed fertility.

The analysis is aimed primarily at showing how the theoretical approach may be implemented empirically with WFS data. To facilitate comparison between countries, emphasis is placed on fairly simple methods and measures. There is, however, some exploration of the use of variant measures at certain places, with little effect on the principal results. Nevertheless, due to some serious weaknesses in the measures that can be constructed using WFS data, the specific empirical magnitudes reported must be viewed as tentative.

The principal innovation of the present approach is the measure of motivation for fertility control. This is the algebraic excess of the potential number of surviving children (derived from household-level estimates of natural fertility and child survival) over desired family size (as reported by respondents). This measure performs best in explaining use of control in competition with a number of alternative motivation measures examined. The implied interpretation is that those households that envisage unregulated fertility as leading to a family size considerably in excess of that desired are under greater pressure to use deliberate control.

It is unlikely, of course, that individual households form specific numerical estimates of their natural fertility as implied by the present regression approach. Rather, the approach should be seen as an attempt at generalizing on how women pick up clues about their own natural fertility. Thus, the pace of early childbearing, prospective exposure (age at marriage, duration of marriage), foetal loss experience, evidence of fecundity problems such as irregular menstruation, etc all probably contribute to a woman's assessment of her potential family size and in turn, if the theory holds, to her motivation to deliberately control her fertility. Clearly, specific research on how such judgments are reached would help validate the present approach.

Another innovation of the analysis is the clarification of the various ways that processes of modernization are linked to fertility. This is illustrated by tracing the channels through which differences in education impinge on observed fertility. Education tends to raise natural fertility within marriage through its effects on secondary sterility and breastfeeding. As regards total natural fertility, however, education has a substantial net negative effect, because its effect in reducing exposure by raising age at marriage more than offsets its positive effect on natural marital fertility. Education also tends to reduce fertility by stimulating use of deliberate control, through both raising the motivation for control and reducing its costs. Increased motivation occurs because education has a sizeable negative impact on family size desires. Although direct regression of fertility on education for Sri Lanka yields a coefficient almost identical with that for Colombia, the present analysis reveals that the relative importance of the mechanisms through which education works is, in fact, rather different between the two countries. It is in such clarification of the links between modernization and fertility, and particularly the mechanisms inducing the use of deliberate fertility control, that the present approach offers the promise of new insights into the determination of fertility behaviour and ultimately of the demographic transition.

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Appendix A – Definitions of Variables

Table A1 Definition and measurement of first-stage variables in tables 1, 2, 3 and 4

Variable	Country	WFS variable	Definition and measurement
Children ever born	Sri Lanka	V208	Number of children ever born.
	Colombia	V208	Same as Sri Lanka.
Regulators, non-regulators	Sri Lanka	V634 S021	Reported ever-use of any method of contraception or abortion, 1 = yes (regulators); 0 = no (non-regulators).
	Colombia	V634 V204	Same as Sri Lanka.
Years since first use of fertility control	Sri Lanka	S006 S009 S013 S017 S023 V009 V010 S007	If first method ever used was pill, IUD, condom or sterilization, the age at first use is given by differencing year at first use of method and year of birth. If another method of fertility control was the first method ever used, age at first use is the mother's age at the birth of the child after which she first used family planning plus two years. If the woman used fertility control before any children were born, her age at first use is her age at marriage. The difference between current age and the age at first use is the years since first use of fertility control.
	Colombia	S215 S222 V009 S216 V010 V204	If first method ever-used was sterilization, age at sterilization is the age at first use. If another method was the first method used, the age of the mother at the birth of the child after which she first used plus one year is the age at first use. If the woman used fertility control before any children were born, her age at first use is her age at marriage. Years since first use is the difference between current age and the age at first use. For women who have used only abortion as a method of fertility control, years of use is calculated as .667 per abortion.
Duration of marriage	Sri Lanka	V010 V109	The difference between current age and age at first marriage.
	Colombia	Ditto	Same as Sri Lanka.
First birth interval	Sri Lanka	V228	First birth interval in months. The mean first birth interval for regulators who did not regulate until after the first birth is substituted for the observed first birth interval of those who regulated before the first birth.
	Colombia	V228	Same as Sri Lanka.
Second birth interval	Sri Lanka	B022 B012	The difference in months between the date of birth of the second child and the date of birth of the first child. The mean second birth interval for regulators who did not regulate until after the second birth is substituted for the observed second birth interval of those who regulated before the second birth.
	Colombia	Ditto	Same as Sri Lanka.

Table A1 *Continued*

Variable	Country	WFS variable	Definition and measurement
Length of breastfeeding	Sri Lanka	V302	Number of months breastfed in last closed birth interval.
	Colombia	V302	Same as Sri Lanka.
Not secondarily sterile	Sri Lanka	V206 V402 V637 V225	Two-category variable: 1 = fecund; 0 = sterile. If currently pregnant. respondent is fecund. If respondent reports fertility impairment, respondent is sterile. If respondent is not a current user of contraception and reports no birth in the past five years, respondent is sterile.
	Colombia	Ditto	Same as Sri Lanka.
Proportion of pregnancy wastage	Sri Lanka	V201 V208	Number of wasted pregnancies divided by the sum of the number of wasted pregnancies plus the number of live births.
	Colombia	V201 V204 V208	The difference between the number of wasted pregnancies and the number of induced abortions divided by the sum of the number of wasted pregnancies plus the number of live births minus the number of induced abortions.
Proportion of child mortality	Sri Lanka	V213 V208	The difference between the number of children ever born and the number currently living, divided by the number of children ever born.
	Colombia	Ditto	Same as Sri Lanka.

Table A2 Definition and measurement of costs of regulation and motivation variables in tables 5, 6, 7, 8, 9 and 10

Variable	Country	WFS variable	Definition and measurement
RC: Costs of fertility regulation variables			
Number of methods known	Sri Lanka	V601 V602 V603 V604 V605 V606 V607 V608 V609 V610 V611 V615	The number of methods of fertility control known to the respondent and reported without special prompting. Sum of '1' responses on variables listed.
	Colombia	Ditto	Same as Sri Lanka.
Efficiency of methods known	Sri Lanka	V616	Categorical variable: 1 = no method of contraception known; 2 = only inefficient method of contraception known; 3 = efficient method of contraception known.
	Colombia	V616	Same as Sri Lanka.
Knowledge of and approval of abortion	Sri Lanka	S021	Knowledge of abortion: 1 = heard of; 0 = never heard of.
	Colombia	S107	The number of situations (out of total of six) in which abortion is considered acceptable.
Distance to nearest family planning outlet	Sri Lanka	–	Not applicable.
	Colombia	S203	Number of kilometers to nearest family planning outlet.
Travel time to nearest family planning outlet	Sri Lanka	–	Not applicable.
	Colombia	S205	Number of minutes' travel to nearest family planning outlet.
Motivation variables			
Cn Potential surviving children	Sri Lanka	–	(N X s), where N is determined by equation in table 2; and s is (1 – the proportion of child mortality).
	Colombia	–	Same as Sri Lanka.
Cd Number of children desired	Sri Lanka	V511	Answer to question, 'If you could choose exactly the number of children to have in your whole life, how many would that be?'
	Colombia	V511	Same as Sri Lanka.
C Number of living children	Sri Lanka	V213	Reported number of living children.
	Colombia	V213	Same as Sri Lanka.
Wants no more	Sri Lanka	V502	If respondent is fecund and wants no more children, wants no more = 1; if respondent is not fecund or wants more children = 0.
	Colombia	V502	Same as Sri Lanka.

Table A3 Definition and measurement of modernization and cultural variables in tables 11, 12, 13 and 14

Variable	Country	WFS variable	Definition and measurement
Modernization variables			
Wife's education	Sri Lanka	S029	Number of single years of education.
	Colombia	V704	Same as Sri Lanka.
Residence	Sri Lanka	V702	Place of usual residence. 1 = rural; 0 = urban, estate.
	Colombia	V702	Place of usual residence, 1 = rural; 0 = urban.
Husband's occupation	Sri Lanka	V804	Dummy variable with categories: farmers (self-employed), agricultural workers (non self-employed), unskilled workers and labourers; omitted category includes white collar workers (professional, clerical, sales), skilled craftsmen, and service workers (private household and other service and related workers).
	Colombia	V804	Dummy variable with categories: farmers (self-employed), agricultural workers (non self-employed), service workers (not including private household workers); omitted category includes white collar workers (professional, clerical, sales), skilled craftsmen, private household workers and unskilled labourers.
Wife's work status before marriage	Sri Lanka	V708	Dummy variable with categories: farm worker (either self-employed or non self-employed), non-farm worker (worked in non-farm occupation); omitted category is no work before marriage.
	Colombia	V708	Same as Sri Lanka.
Cultural variables			
Ethnicity	Sri Lanka	V707	Dummy variable with categories: Sri Lanka Tamil, Indian Tamil, Sri Lanka Moor; omitted category is Sinhalese plus others.
	Colombia	–	Not applicable.
Region	Sri Lanka	–	Not applicable.
	Colombia	V701	Dummy variable with categories: Atlantic, Oriental, Central, Bogotá; omitted category is Pacific.

Appendix B – The National Research Council

The National Research Council was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the Federal Government. The Council operates in accordance with general policies determined by the Academy under the authority of its Congressional charter of 1863, which establishes the Academy as a private non-profit-making, self-governing membership corporation. The Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public and the scientific and engineering communities. It is administered jointly by both Academies and the Institute of Medicine. The National Academy of Engineering and the Institute of Medicine were established in 1964 and 1970 respectively, under the charter of the National Academy of Sciences.

PANEL ON FERTILITY DETERMINANTS

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