On the Prediction of Family Planning Practice in Pakistan: A Methodological Note

HUDA C. ZURAYK*

Introduction

The high rate of population growth in the developing countries at the present time—due to a fall in the level of mortality while fertility maintains its high level—is threatening to absorb the benefits achieved by those countries through the process of development, and is adversely influencing the health and welfare of individual families.

The approach adopted by most governments of developing countries to solve the population problem has been increasingly the incorporation of population objectives within their development plans, and the establishment of family planning programmes, or the support of family planning activities [1]. Such programmes and activities have concentrated mainly on providing family planning services to couples on a voluntary basis to prevent unwanted births [2]. As such, they have come under severe criticism on two accounts, (a) the objective they set for themselves of preventing unwanted births is not sufficient to reduce the birth rate to the desired level. Emphasis should be put on motivating couples to reduce their desired family size. And (b) the provision of services within family planning programmes has not been adequate, and needs improvement [3,4].

It is evident, from the experiences of family planning programmes in developing countries over the past decade that whereas an available supply of contraceptives is a necessary condition for increasing contraceptive behaviour in a population, it is not sufficient to cause an increase in use capable of reducing

*Huda C. Zurayk is Assistant Professor, Department of Epidemiology and Biostatistics, American University of Beirut, Beirut, Lebanon. Research for this article was carried out while the author was a doctoral candidate in the Department of Biostatistics, The Johns Hopkins University. Part of the data processing cost was supported by a USAID Grant (No. AID/csd-2956). The author wishes to thank Professors Ismail Sirageldin, Richard Royall and David Duncan for their guidance and helpful comments, and Farida Shah for her assistance in preparing this manuscript.

the birth rate appreciably. In order to achieve the goal of a reduced rate of growth, therefore, a policy to supply contraceptives on a nationwide basis should be accompanied by efforts to increase the demand for contraception in the population.

In this paper we are concerned with analyzing the motivational forces that operate on Pakistani couples as of 1968-69 to create a demand for contraception. Some of these forces are policy variables that are already being manipulated by governments to serve objectives of economic development. In clarifying the channels of influence of these variables on the demand for contraception, we hope to affirm the role they can play if manipulated by an overall developmental policy in which population objectives are integrated with other objectives of economic development.

Some Theoretical Considerations

We shall attempt first to develop a model that relates demand for contraception to family characteristics hypothesized to determine demand. We shall base our model on three assumptions that reflect prevalent patterns of fertility and contraceptive behaviour in Pakistan. The model shall assume: (a) that women marry at approximately the same young age and that reproduction starts with marriage; (b) that a couple makes decisions related to their family size on the basis of a rational consideration of the expected values and costs of additional children; and (c) that contraception is used mainly to limit rather than to space births. Under these three assumptions, the model hypothesizes a couple's demand for contraception to be a function of the following factors: the pressure of unwanted children, the fecundity of the wife, the cost of contraception, and the couple's attitude towards contraception.

Demand for Contraception

We shall define demand for contraception as the probability of ever use, ever use indicating past and/or current use of any type of contraceptive, traditional or modern. Although current use is a more relevant index of demand, its level is still low in Pakistan (Table 1) leaving us with too narrow a range to investigate the determinants of demand [11]. The relatively recent nature of the Pakistan Family Planning Programme, however, makes ever use a measure of recent behaviour and thus an appropriate representation of demand.[1]

The Pressure of Children

In considering the pressure of children as a factor influencing demand for contraception, we shall be adopting a simplified economic approach to fertility behaviour [5,6]. The economic approach to fertility behaviour regards children as any other commodity yielding utility to the family. Utility from children, however, is derived from child quality which is produced at some cost to the family in terms of the time and the goods used in the production of that quality. In making a rational decision on desired family size with a view to maximizing family welfare, therefore, a couple would only want to have an

[1]Future use, as indicated by intention, is an important element of the "demand creation process," but our interest is in reported behaviour. For an analysis of intention, see [12].

additional child as long as the utility added by that child is greater than the added cost, as perceived by the couple. A pressure of children is created if, upon attaining the desired number of children, a couple faces obstacles in controlling its fertility and has to go on reproducing. The pressure of children is expressed in terms of the disutility of children born beyond those desired.

Table 1

Percentage Distribution by Use Status and Type of Contraceptive Method Used, Based on 2890 Currently Married Pakistani Women Forty-nine Years of Age and Under*

Use Status	Contraceptive Method Used	Percentage	Distribution
Past use			6.5
Current use			5.5
Ever Use+			12.0
	IUD	4.4	
	Male sterilization	.1	
	Female sterilization	.6	
	Pills	1.3	
	Condoms	3.0	
	Foam tablets	1.2	
	Diaphragm	.6	
	Tampon	.1	
	Jelly or Cream	.4	
	Abortion	.1	
	Abstinence	2.3	
	Breast Feeding	1.1	
	Rhythm	.7	
	Withdrawal	1.6	
	Douche	.6	
	Other	.8	
Never			88.0
			100.0

*Weighted percentages

+A couple may have used more than one contraceptive method.

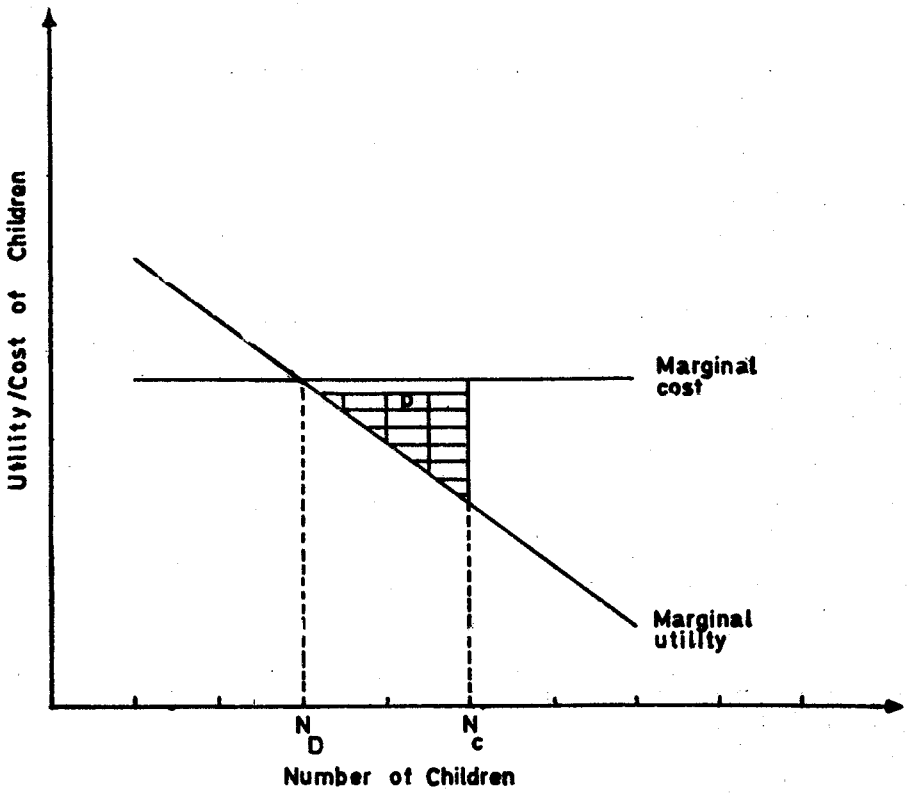
We can represent the pressure of children on a couple by defining two functions: a demand and a cost function with respect to the number of children. These two functions, demand and cost, express the couple's assessment of the utility of each additional child (marginal utility), and the cost of each additional child (marginal cost), respectively, as perceived by the couple before bringing that child into existence.

The utility an additional child brings to the family in Pakistan is a result of his two equally important functions in the family (a) the child is a consumption good, his presence bringing joy and social prestige to the family; and (b) the child is an investment good being a work asset and a security for parents in old age [7]. The utility of each additional child decreases as the number of children increases. The level and slope of the demand curve for additional children are determined by the couple characteristics and their social environment.

A child also entails costs to the parents that are partly financial costs consisting of the cost of shelter, food, clothing, schooling, and such necessities; partly opportunity costs consisting of the sacrificed income of the mother and the sacrificed utilities of other commodities; and partly non-economic costs reflecting the strain imposed by an additional child on the health of the mother, as well as the leisure time sacrificed by having an additional child [8]. In Pakistan the financial costs of children dominate. The reduction in the cost of an additional child can, therefore, be considered minimal because the capacity for sharing material goods is limited, particularly when there is no spacing between children. We shall consider the marginal cost to remain constant for each additional child, the level of the curve being determined by the characteristics of the couple, and their social environment.

Figure 1 presents a couple's demand (marginal utility) and cost (marginal cost) functions with respect to the number of children. The couple's desired family size, N_D, is determined by the intersection of these two curves. In order to maximize family welfare, the couple would like to limit its number of children to N_D, and a demand for contraception arises when the couple's number of living children, N_C, reaches N_D. However, obstacles may prevent the couple from controlling its fertility and N_C may come to exceed N_D. A pressure of children is thus created, whose strength (represented by the shaded area in Figure 1) is determined by the shape of the demand and cost functions of children. The pressure of children, P, positively influences a couple's demand for contraception, and is itself determined by couple characteristics that are important determinants of the demand function and cost function with respect to number of children. We can view the pressure of children, therefore, as an intervening variable linking couple characteristics that determine the demand and cost functions of children, to the demand for contraception.

The factors hypothesized by our model to be the important determinants of the utility added and the cost entailed by an additional child in Pakistan are: the education of the wife (E_w), the education of the husband (E_h), the level of urbanization of the place of residence (U_r), the number of living boys (N_b) and the number of child deaths (N_d). At any moment in time, these variables,



N_D: desired number of children
N_c: number of living children
p: pressure of children

Figure 1

Determination of Pressure of Children on a Couple

together with the number of living children (N_c), determine the pressure of children on a couple and thus influence the couple's demand for contraception.[2]

Fecundity of the Wife

On attaining the desired family size, an important determinant of a couple's level of demand for contraception is the motivation to use contraception as indicated by the fecundity of the wife: the higher the fecundity of the wife, the higher the probability of conception following intercourse and the greater the couple's need for contraception.

A usual measure of fecundity, the age of wife (A_w) is a simplified measure which ignores other causes of infecundity. However, in the absence of other relevant information, the age of wife serves as an appropriate indicator of a couple's need for contraception.

Cost of Contraception

One of the obstacles to a full development of a couple's demand for contraception is its cost. However, it is difficult to define and measure the cost of contraception. Since in Pakistan contraceptives are provided by the Family Planning Programme at minimum charge, money price does not form a large part of the cost of contraception and can be ignored. Moreover, contraception has been defined to include traditional contraceptives which have no money cost. Other aspects of contraception can be viewed by the user as a cost to using contraception: elements such as discomfort in use, bothersome or harmful side effects, ineffective protection; but these are elements of cost that are difficult to measure.

We single out two measurable elements of cost: (a) the cost of obtaining proper information; and (b) the cost of transportation to the source of supply. Since with education and urbanization information on contraception becomes more easily accessible, we shall consider that some of the cost effect on the demand for contraception is included in the effects of the education of wife, education of husband and urbanization variables. The cost of transportation to the source of supply is measured in this study by the distance from a family planning place in terms of time equivalence, that is; the time it takes for the woman to reach a family planning place. We shall, therfore, use the distance from a family planning place variable (d_p) as an indicator of cost, even though this element represents only part of the cost of contraception.

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[2]The occupation of the husband and family lifetime income were also considered to be important determinants of the marginal utility and marginal cost of children. However, since the relevant occupational differential is between agricultural and non-agricultural occupations, and since an occupational variable classifying occupations into agricultural and non-agricultural would be highly correlated with the level of urbanization of the place of residence, we considered the urbanization variable (U_r) to also represent a rough breakdown of occupations: the high urban areas being considered highly non-agricultural, and the rural areas being considered mainly agricultural. Moreover, since information on family income was obtained only for couples for which the husband was also interviewed (50 percent of the sample of women), and because the family income for these couples was found to be highly correlated with the education of the husband, we considered the education of the husband variable (E_h) to also indicate family lifetime income.

Attitude Toward Contraception

Another obstacle that may stand in the way of a couple's controlling its fertility is the couple's psychological and moral readiness to interfere with the process of reproduction, and to use modern contraceptives. This is particularly relevant in Pakistan where society is strongly traditional.

Since a development in favour of regulating fertility and using contraception accompanies education, we shall consider couple attitude towards contraception as another intervening variable through which the education of the wife and the education of the husband wield their influence on demand for contraception. These two variables will, therefore, be considered as proxy measures of the couple's attitude towards contraception.

Data Source

The analysis will be based on data from the Pakistan National Impact Survey a nationwide KAP survey organized in 1968 by the Pakistan Family Planning Council [9, 10, 11, 12]. The Survey covered a probability sample of 3849 households. The data entering our analysis relate to a subsample of 2890 currently married women under fifty years of age.

Methodology for Analysis

We can specify our model for the demand for contraception in Pakistan, in terms of the symbols introduced above, as follows:

$$D = d(E_w, E_h, U_r, N_b, N_d, N_c, A_w, d_p) \quad .. \quad .. \quad (1)$$

Where $\frac{\partial D}{\partial E_w} > 0$, $\frac{\partial D}{\partial E_h} > 0$, $\frac{\partial D}{\partial U_r} > C$, $\frac{\partial D}{\partial N_b} > 0$, $\frac{\partial D}{\partial N_d} < 0$

$\frac{\partial D}{\partial N_c} > 0$, $\frac{\partial D}{\partial A_w} < 0$, $\frac{\partial D}{\partial d_p} < 0$.

We shall use two multivariate techniques of analysis in analyzing the data obtained from the Impact Survey within the context of our model. The two techniques are: Multiple Linear Regression, and a computerized classification analysis technique called the Automatic Interaction Detector (AID) [13, 14].

In analyzing data from large surveys, particularly social surveys where many variables are being investigated, the most useful multivariable technique of analysis to-date is Multiple Linear Regression. To express a theoretical model in multiple linear regression form, however, requires a knowledge of the nature of the relationships between the variables in the model, particularly with respect to interaction effects. A first step in the analysis of the data is usually, therefore, a consideration of cross-tabulations of the variables in the model, to point to possible interaction effects. As a first step in

our analysis, we shall use the Automatic Interaction Detector technique as a simple and efficient procedure of bringing out interactions in the effects of the explanatory variables.

The use of the AID technique provides an added benefit. The technique classifies the population into major groups that differ most with respect to the level of the dependent variable.[3] This classification is in itself a meaningful representation of what the data have to say regarding demand for contraception in Pakistan, and has important and useful policy implications and interpretations.

We shall conduct the AID analysis in two stages. In the first stage, we shall introduce the explanatory variables which represent the socio-economic and reproductive characteristics of a couple, because they are believed to be logically prior in their effect on demand to the cost of contraception. In the second stage, we shall introduce the distance from a family planning place variable representing the cost of contraception.

In undertaking a multiple linear regression analysis of the data, we shall use a computerized regression programme called Multiple Classification Analysis (MCA) [15]. The main advantage of MCA is its ability to deal with categorical variables. However, it has the shortcoming that it automatically converts all the variables—with no differentiation between the variables that are, and the variables that are not, linearly related to the dependent variable—into dummy variables. With a large sample size such as the one we have, the loss of efficiency from an increased number of parameters is minimal.

We can express our model for the demand for contraception in Pakistan in the regression form underlying the MCA analysis as follows:[4]

$$y_i = \mu + \beta_{1j} + \beta_{2k} + \beta_{3m} + \beta_{4n} + \beta_{5r} + \beta_{6s} + \beta_{7t} + \varepsilon_i \quad .. \quad (2)$$

Where

y_i is a binary dependent variable representing ever use

μ is the average rate of ever use in Pakistan.

β_{1j} is the adjustment to the average rate of ever use induced by category j of the education of the wife variable (j=1,2,3 or 4).

β_{2k} is the adjustment to the average rate of ever use induced by category k of the education of the husband variable (k=1,2,3 or 4)

β_{3m} is the adjustment to the average rate of ever use induced by category m of the level of urbanization variable (m=1, 2 or 3).

β_{4n} is the adjustment to the average rate of ever use induced by category n of the number of living boys variable (n=1,2, ..., or 6).

β_{5r} is the adjustment to the average rate of ever use induced by category r of the number of child deaths variable (r=1, 2,....., or 6).

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[3]For a more detailed description, see appendix A.

[4]Because of problems in its definition, we are excluding the distance from a family planning place (d_p) from the regression analysis. For a more detailed presentation, see appendix B.

β_{6s} is the adjustment to the average rate of ever use induced by category s of the number of living children variable (s = 1, 2, ..., or 8).

β_{7t} is the adjustment to the average rate of ever use induced by category t of the age of the wife variable (t = 1, 2, ..., or 8).

Results of the Analysis

The AID Tree Classification

The result of the AID analysis of the Impact Survey data within the context of our model for the demand for contraception in Pakistan is presented in a tree summary of the data as shown in Figures 2a and 2b.

The First Stage Analysis

Table 2 presents the best division on each explanatory variable in the total sample of 2890 wives, and ranks the variables in terms of their explanatory power. The number of living children variable shows highest explanatory power indicating its importance in determining demand for contraception in Pakistan. Wives with less than four living children show a rate of ever use lower than that for wives with at least four living children (.06 verses .21). The split at four living children coincides with other results of the Impact Survey related to a question on the "ideal" number of children. The mean response to that question was 4.4, and an ideal of four was the most frequent response given by 37 percent of the total sample [10]. This seems to suggest that a family size of four is the accepted norm in Pakistan and explains the higher demand for contraception for wives with at least four living children.

We examine next the group of high parity wives with at least four living children (Figure 2a, group 1) and note that education of the wife shows highest explanatory power separating the illiterate wives, with a rate of ever use of .19, from the literate wives, with a much higher rate of ever use of .57. The rates of current use in these two groups are .09 and .30 respectively.

The high parity literate wives (group 3) are mainly composed of wives of educated men who live in urban areas. Thus, it seems that in separating the literate high parity wives, we may also be capturing the effects of education of the husband and the level of urbanization variables on demand for contraception. However, further division of this group of wives by level of education, produces the group of wives (group 7) with at least six years of schooling who have the highest rate of ever use (.68). This seems to suggest a greater influence of the education of the wife variable on desired family size and thus on demand for contraception.

On the other hand, the high parity illiterate wives (group 2), show a rate of ever use which is only a little over the average rate of ever use in Pakistan. The partitioning of this group indicates that number of living children, combined with level of urbanization, has a considerable effect on demand for ccontraception in the absence of effect of wife's education. Thus, the rate of ever use for illiterate urban wives with at least seven living children is .40 (group 11), and .26 for those with four to six living children (group 9).

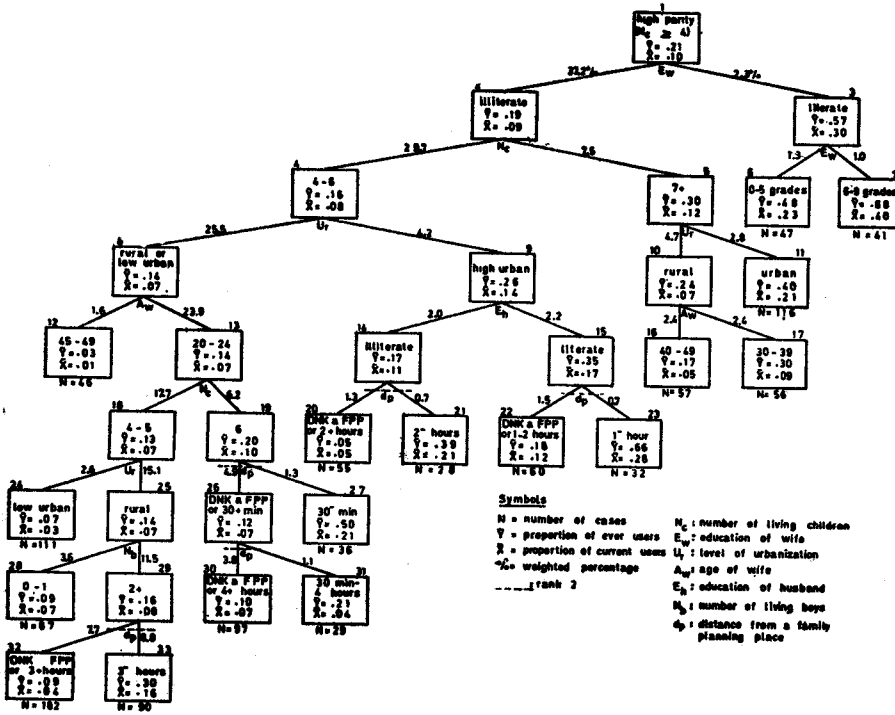


Figure 2 a

AID Tree Summary of the Impact Survey Data from Pakistan: High Parity Wives

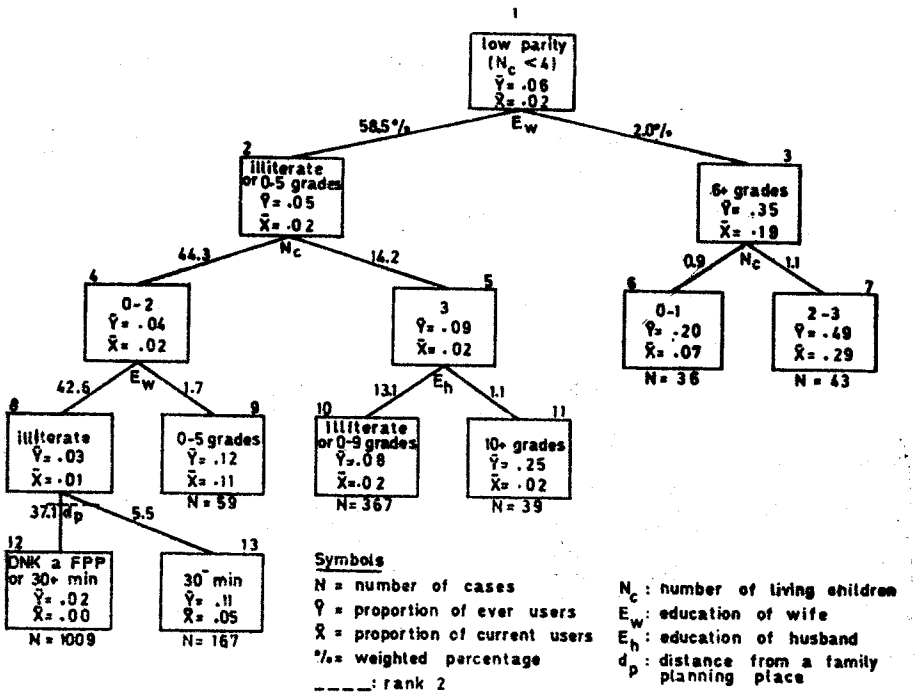


Figure 2b

AID Tree Summary of the Impact Survey Data from Pakistan: Low Parity Wives

Table 2

Best Split of Total Sample According to Each Explanatory Variable

Explanatory Variable	Best Split	No. of Cases	Percent of Total (weighted)	Rate of Ever Use	Proportion of Variance Explained
Number of Living Children (N_c)	0—3	1720	60.5	.06	.052
	4+	1170	39.5	.21	
Number of Living Boys (N_b)	0—2	2167	76.0	.08	.043
	3+	723	24.0	.24	
Education of Wife (E_w)	illiterate	2641	93.4	.10	.039
	literate	249	6.6	.36	
Level of Urbanization (U_r)	high urban	625	14.8	.24	.025
	low urban or rural	2265	85.2	.10	
Age of Wife (A_w)	15—30	1535	53.6	.07	.022
	30—49	1355	46.4	.17	
Education of Husband (E_h)	illiterate or 0—5 grades	2129	76.4	.10	.015
	at least 6 grades	761	23.6	.19	
Number of Child Deaths (N_d)	none	1578	54.6	.10	.005
	1+	1312	45.4	.14	
Distance from a FPP (d_p)	does not know FPP or 4+ hours	1936	68.5	.06	.080
	0—4 hours	954	31.5	.25	

It is interesting to note further that for high parity illiterate wives living in urban areas (groups 9 and 11) the education of the husband appears to be an important determinant of demand.[5] The wives with medium parity (four to six children) whose husbands are literate (group 15) show a rate of ever use of .35. The wives with high parity (at lease seven children) whose husbands have had at least six grades of schooling show a rate of ever use of .48. In urban areas of Pakistan social and occupational mobility is relatively high, and inasmuch as education of the husband is a vehicle for such mobility, it seems to be reducing the desired family size, since large family size forms an obstacle to mobility.

In the rural areas (groups 8 and 10) age of wife is an important predictor and exerts a negative effect on demand for contraception. Despite their illiteracy and rural environment, the younger wives behave differently from the older generation of wives in terms of their demand for contraception.

We move next to consider the group of low parity wives with less than four living children (Figure 2b, group 1). In building our model for the demand for contraception in Pakistan, we made a priori assumption that contraception has been used mainly to limit, rather than to space births. The low rate of ever use of .06 among the low parity wives, and the associated rate of current use of .02, support our assumption.

The group of low parity wives is first split by education of the wife variable emphasizing the importance of this variable in Pakistan in reducing the desired family size below the society's normative level, and in producing an awareness of the advantages of spacing births and of the availability of contraception. However, the increase in demand for contraception with education of the wife among the low parity is not as great as that among the high parity wives. Wives with up to five grades of schooling (group 2) show a low rate of ever use of .05. The wives with at least six grades of schooling, on the other hand, show a rate of ever use of .20 for those having up to one child (group 6), and of .40 for those having at least two children (group 7). The comparable high education group among the high parity wives (Figure 2a, group 7) shows a rate of ever use of .68.

For wives with low parity and low education (group 2), the number of living children seems to do best in explaining demand; wives with less than three living children show a lower rate of ever use than wives with three living children (.04 verses .09). Moreover, despite the low parity and low education in these two groups (groups 4 and 5), education of the wife and education of the husband exert a positive influence on demand for contraception. Wives with three living children whose husbands have a high level of education (group 11) report a rate of ever use of .25. Wives with less than three living children who have themselves some education (group 9) report a rate of ever use equal to the average rate of ever use in Pakistan. The remaining group of wives with low parity and no education (group 8), who form the largest final group of the first stage analysis, show the least demand for contraception.

[5]For group 11 the education of the husband variable is best able to explain use, but the split does not explain enough of total variability to be eligible to appear in the tree.

We can now summarize the results of the First stage AID analysis of the Impact Survey data as they relate to our model for the demand for contraception in Pakistan. The AID classification has partitioned the total sample of 2890 wives, according to the socio-economic and reproductive characteristics of the couples, into 18 final groups that explain 14.02 percent of total variability. The classification isolates two extreme groups in terms of their demand for contraception as follows:

(1) The larger group of wives (42.6 percent)[6] who are of low parity and also are illiterate. These wives reveal almost no use of contraception—only three percent have ever used, and only one percent are current users (Figure 2b, group 8).

(2) The much smaller group of wives (1.0 percent) who are of high parity and are also of relatively high education. These wives reveal a relatively high rate of ever use (.68) and current use (.40) (Figure 2a, group 7).

The two extreme groups are determined by only two variables: the number of living children and the education of the wife. Within the context of our model, education of the wife is an important determinant of desired family size which combines with number of living children to determine pressure of children and thus the couple's demand for contraception.

The other variables which determine desired family size appear at later stages of the tree. The level of urbanization variable shows prominence only for illiterate wives of high parity (Figure 2a, groups 4 and 5). Education of the husband also appears important only with wives of low or no education (Figure 2a, group 9 and Figure 2b, group 5). It seems that these two variables are demonstrating their positive influence on demand only when the stronger effect of education of the wife is not present.

The remaining two variables, number of living boys and number of child deaths, considered as determinants of desired family size, show little importance. The number of living boys variable is highly correlated with the number of living children variable ($r = .80$), so that the early splits by number of living children may have reduced the explanatory power of the number of sons. The number of child deaths variable does not seem to have an effect on demand in any subgroup of wives, lending support to the hypothesis that in the face of the high level of child mortality in the community, the couple's personal experience with child death does not seem to influence their desired family size.

The age of wife variable, measuring fecundity, demonstrates secondary influence on demand for contraception. It shows prominence in only two groups consisting of high parity illiterate wives living in rural and low urban areas (Figure 2a, groups 8 and 10). The secondary position of age of wife may be in part a result of its correlation though moderate ($r = .62$), with number of living children.

[6]All percentages are weighted inversely to the sampling rates in the urban and rural strata to reflect the population distribution in Pakistan.

The Second Stage Analysis

The distance from a family planning place variable is introduced after the other variables of the model have exhausted their ability to explain variation in demand. The distance variable causes splits on some groups indicating for the most part—despite small group sizes the negative effect of distance on demand.

Detection of Interactions

In its description of how the explanatory variables of the model combine to determine demand, the AID tree summary also enables an investigation of interaction effects. We note that the tree summary is symmetrical in its early stages in terms of the variables that show prominence in complementary branches of the tree, indicating that no strong interactions exist. Beyond the second split on number of living children, however, as symmetry appears, indicating some interactions at secondary stages.

Although the tree classification is symmetrical in terms of its first breakdowns by number of living children and education of the wife, we further examine these variables for an interaction effect.

If we were to investigate the existence of an interaction in the effect of number of living children and the education of the wife on demand for contraception by the usual procedure, we would have constructed a cross-tabulation such as that shown graphically in Figure 3. The cross-tabulation, however, shows some cells with a small number of observations, so that it is unable to accurately reflect patterns of relations. The Automatic Interaction Detector technique overcomes this problem in its tabulation procedure by combining adjacent cells whenever the cell means are close in value. Figure 4 presents graphically the cross-tabulation of number of living children and the education of the wife variable produced by the AID analysis. Because of the extreme skewness of the education variable, we still find some cells with a small number of observations at higher educational groups. Nevertheless, the combined effect of the number of living children and the education of the wife on demand for contraception is brought out more clearly in Figure 4 than in Figure 3.

Figure 4 indicates a differential effect of number of living children on the demand for contraception within education of wife groups. Among the low parity wives, wives with higher educational attainment exhibit a much sharper increase in demand with increase in number of living children. However, it is difficult to make a similar comparison between the illiterate and the literate among the high parity wives because of the small size of the latter group. We shall, nevertheless, construct an interaction variable from combinations of number of living children within education groups as shown in Table 3. The categories representing the interaction variable are the ranks of the combinations of number of living children within education groups when ordered in terms of their expected effect on demand.

Validation of the Results of the AID Analysis

The results of the AID analysis of the Impact Survey data from Pakistan presented above have produced a scheme of operation of our model for the

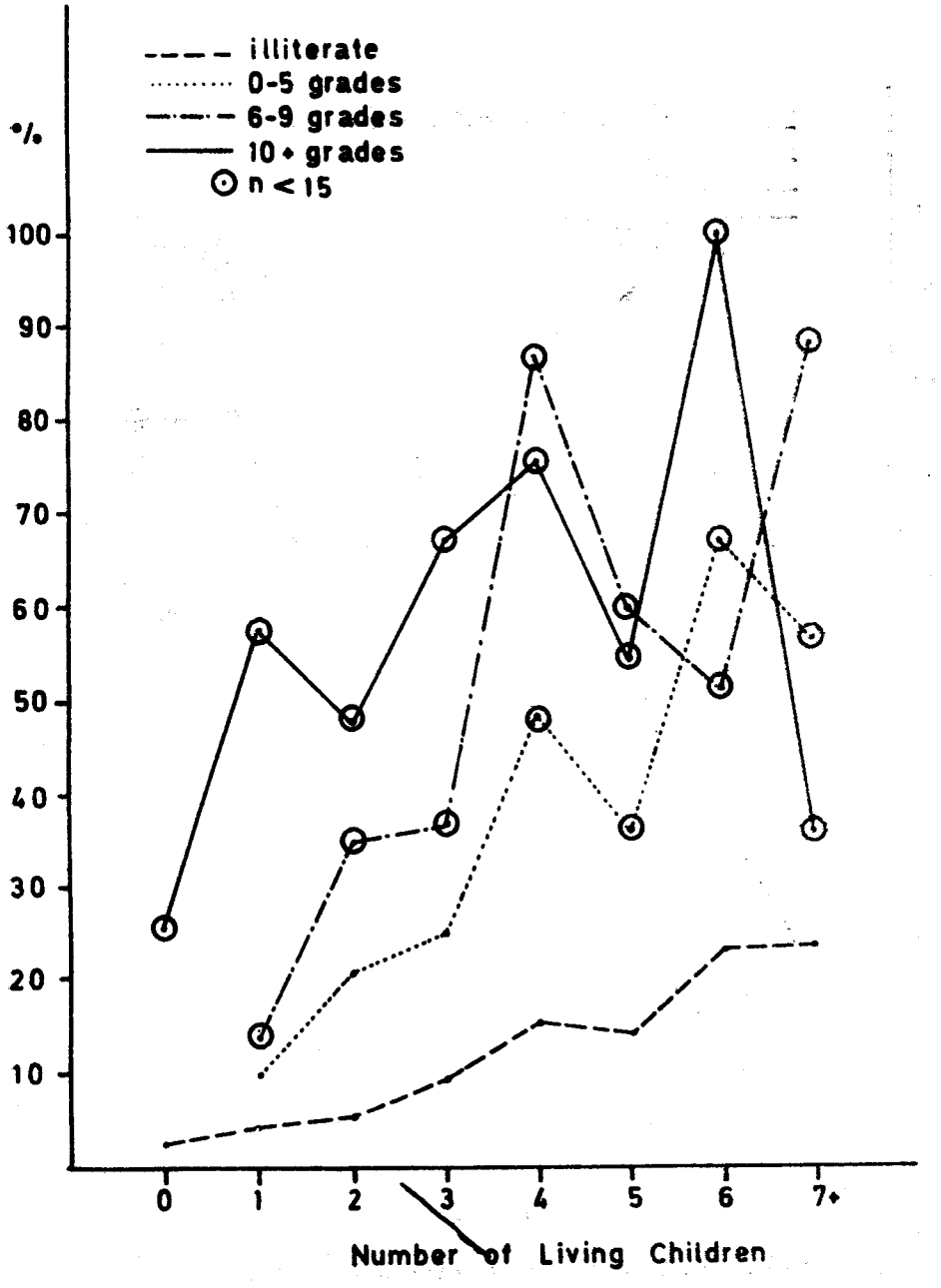


Figure 3

Dependence of Ever Use on Number of Living Children Within Education of Wife Group

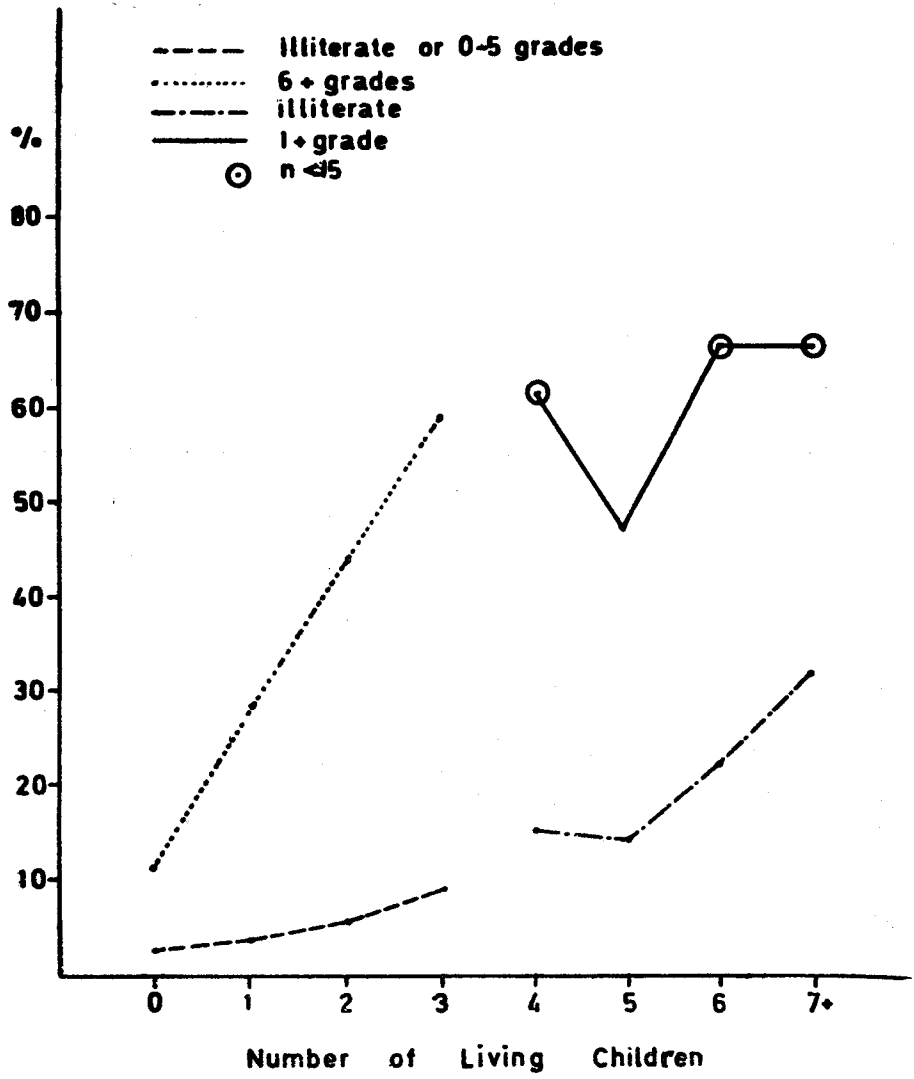


Figure 4

Dependence of Ever Use on Number of Living Children with Parity and Education of Wife Groups as Determined in the AID Analysis

demand for contraception in Pakistan which gains our confidence because it is largely consistent with theoretical expectations. However, since the analysis is based on a search strategy that is difficult to study probabilistically, we have no statistical measure of confidence in the results.

One way to validate the results of the AID analysis is to apply the technique to a similar set of data. The National Impact Survey was carried out in both Pakistan and Bangladesh at a time when they formed two wings of one country. Our study is concerned with present day Pakistan and has thus used only one part of the Impact Survey data. Inasmuch as the main forces determining demand for contraception are common to developing countries, especially to countries tied together as were Pakistan and Bangladesh, we expect the Bangladesh data to point to similar patterns of relations as regards the determination of demand for contraception. We shall thus validate our findings in Pakistan by applying the AID technique of analysis (with the same parameters) to the Bangladesh data. The Bangladesh sample consists of 3061 currently married women up to 49 years of age who show a rate of ever use of six percent.

The tree summary of the Impact Survey data from Bangladesh is presented in Figures 5a and 5b. We note most importantly that it agrees with our major finding that the number of living children and the education of the wife are important determinants of demand for contraception, showing the same pattern of effects. However, it shows two basic differences from the scheme presented by the Pakistan data.

The first difference is the failure of the level of urbanization variable to show prominence for any subgroup of Bangladesh wives, whereas urbanization plays an important role in explaining use among high parity illiterate wives in Pakistan. However, this is probably due to the low level and extent of urbanization in Bangladesh (only five percent of the population of Bangladesh reside in urban areas, and these areas probably correspond to areas of low urbanization in Pakistan), and does not render suspect the influence displayed by the level of urbanization variable in Pakistan.

The second difference is the increased prominence of the education of the husband variable as a determinant of demand for contraception in Bangladesh. A more detailed investigation is needed to explain this difference. We shall not, however, discuss the results of the AID analysis of the Bangladesh data further since our main intent has been to demonstrate the ability of the AID technique to bring out important patterns of relations, and thus to give support to the conclusions of the AID analysis on demand for contraception in Pakistan.

The Regression Model

In the previous section on methodology we expressed our model for the demand for contraception in Pakistan in the regression form (2) underlying the MCA analysis. The probability of ever use for the i^{th} individual appears as follows:

$$P_i = \mu + \beta_{1j} + \beta_{2k} + \beta_{3m} + \beta_{4n} + \beta_{5r} + \beta_{6s} + \beta_{7t} \quad .. \quad .. \quad (3)$$

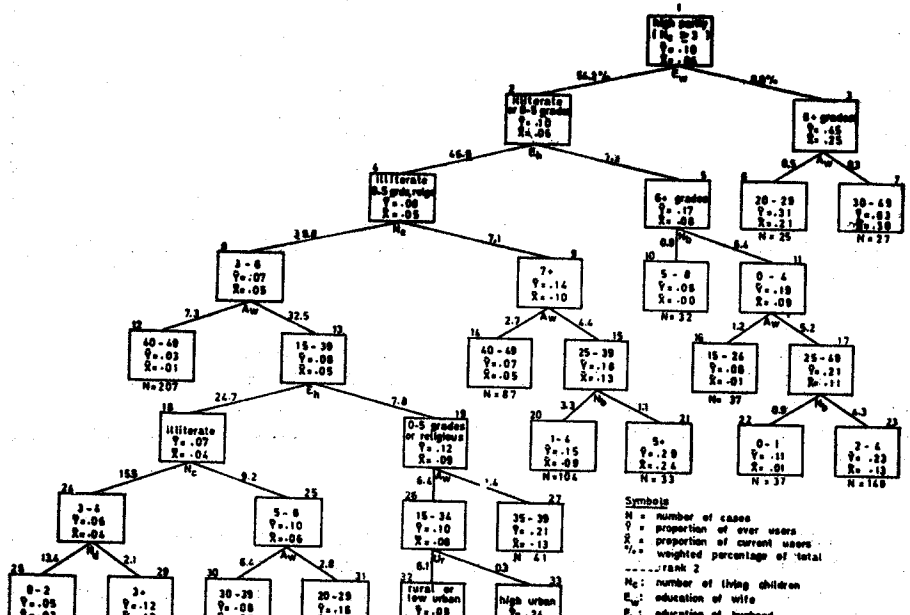
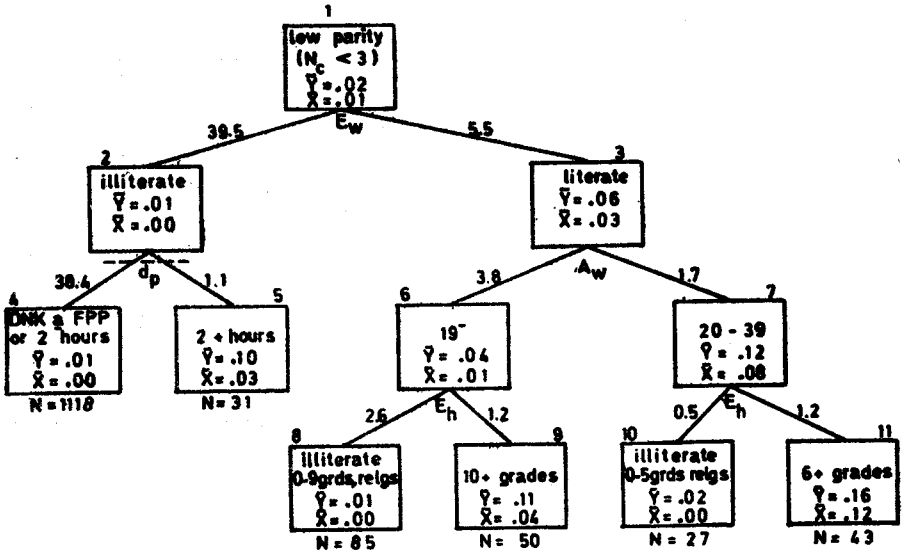


Figure 5a

AID Tree Summary of the Impact Survey Data from Bangladesh: High Parity Wives



Symbols

N = number of cases
Ȳ = proportion of ever users
X̄ = proportion of current users
% = weighted percentage of total
____ : rank 2

N_c : number of living children
E_w : education of wife
A_w : age of wife
E_h : education of husband
d_p : distance from a family planning place

Figure 5b

AID Tree Summary of the Impact Survey Data from Bangladesh: Low Parity Wives

where the β's represent the adjustments to the average rate of ever use in Pakistan (μ), induced by those characteristics of the i^{th} individual which are included in our regression model for the demand for contraception in Pakistan, namely, the education of the wife, the education of the husband, the level of urbanization of the place of residence, the number of living boys, the number of child deaths, the number of living children, and the age of the wife.

In attempting to get the best regression formulation of our model for the demand for contraception in Pakistan, however, we have investigated whether replacing the number of living children and the education of the wife variables by the interaction variable, suggested by the AID analysis and defined above (Table 3), increases the explanatoy power of the model. The test showed that conducting the analysis with the simple model of main effects only and with the model incorporating the interaction effect produced little difference in the proportion of total variance explained (.143 verses .146 respectively). We shall, therefore, use the simple regression model to measure the contribution of each explanatory variable to demand for contraception in Pakistan.

The estimates of the parameters of the regression model are presented in Tables 4 to 10. Examining the adjusted deviations reveals, for each explanatory variable, the same pattern in its influence on demand for contraception as was depicted in the earlier analysis.

Table 4 demonstrates the importance of the influence of the education of the wife on demand for contraception. Whereas the illiterate wives show a slightly lower than average demand for contraception, education of the wife at any level raises the couple's probability of ever use, the addition to the average rate of ever use ranging from .11 for women with some primary education to .36 for women with more than nine grades of schooling. Education of the wife thus seems to exert a large net effect on demand for contraception.

In contrast, the education of the husband variable reveals a mild net effect on demand for contraception. Table 5 shows that wives with illiterate husbands report a slightly lower than average rate of ever use, and that education of the husband induces a gradual minimal rise in the couple's demand for contraception. The AID analysis, looking at effects within subgroups rather than at overall effects, has shown that the education of the husband gains prominence with women of low education specifically those residing in highly urbanized areas.

Table 6 examines the net effect of level of urbanization on demand for contraception, and reveals that a high level of urbanization is needed to produce a positive, and yet relatively moderate rise in demand. The AID analysis has brought out the special importance of this variable among the illiterate women of high parity.

Table 7 reveals that couples with less than two living sons are below the average level of demand for contraception in Pakistan. After controlling for the influences of the other explanatory variables, the number of living sons seems to have a mild effect on demand for contraception.

Table 8 describes the net effect of a couple's experience with child mortality on demand for contraception and shows that, except for probably arti-

Table 3

Constructing the Interaction Variable from Combinations of Number of Living Children Within Education of the Wife Group

Category of the Interaction Variable	Education of Wife	Number of Living Children	Number of Cases
1	Illiterate	0—1	795
2	,,	2	381
4	,,	3	383
8	,,	4—6	853
10	,,	7+	229
3	0—6 grades	0—2	59
5	,,	3	23
9	,,	4—6	37
6	6 grades or more	0—1	36
7	,,	2—3	43
11	,,	4—6	32
12	Any level	7+	19

Table 4

Estimates of Deviations from the Overall Rate of Ever Use in Pakistan For Each Category of the Education of Wife Variable*

Education of Wife (E_w)	Number of Cases	Unadjusted Deviation	Adjusted Deviation	Standard Error for Adjusted Deviation
Illiterate	2641	—0.017	—0.013	.002
0—5 grades	129	0.150	0.110	.030
6—9 grades	73	0.309	0.250	.042
10+ grades	47	0.403	0.357	.055

*Estimated at .12 from the data.

Table 5

Estimates of Deviations from the Overall Rate of Ever Use in Pakistan For Each Category of the Education of Husband Variable*

Education of Husband (E_h)	Number of Cases	Unadjusted Deviation	Adjusted Deviation	Standard Error for Adjusted Deviation
Illiterate	1764	—0.028	—0.012	.004
0—5 grades	365	0.007	0.003	.015
6—9 grades	408	0.042	0.025	.014
10+ grades	353	0.111	0.039	.019

*Estimated at .12 from the data.

Table 6

Estimates of Deviations from the Overall Rate of Ever Use in Pakistan For Each Category of the Level of Urbanization Variable*

Level of Urbanization (U_r)	Number of Cases	Unadjusted Deviation	Adjusted Deviation	Standard Error for Adjusted Deviation
High urban	625	0.123	0.063	.014
Low urban	542	0.016	— 0.010	.015
Rural	1723	— 0.028	—0.011	.004

*Estimated at .12 from the data.

Table 7

Estimates of Deviation from Overall Rate of Ever Use in Pakistan For Each Category of the Number of Living Boys Variable*

Number of Living Boys (N_b)	Number of Cases	Unadjusted Deviation	Adjusted Deviation	Standard Error for Adjusted Deviation
No boys	813	—0.079	—0.017	.014
One boy	756	—0.041	—0.022	.011
Two boys	598	0.022	0.007	.012
Three boys	377	0.118	0.053	.017
Four boys	220	0.096	0.010	.024
Five boys or more	126	0.170	0.046	.032

*Estimated at .12 from the data.

Table 8

Estimates of Deviations from the Overall Rate of Ever Use in Pakistan For Each Category of the Number of Child Deaths Variable*

Number of Child Deaths (N_d)	Number of Cases	Unadjusted Deviation	Adjusted Deviation	Standard Error of Adjusted Deviation
No deaths	1578	—0.020	—0.008	.006
One death	637	0.015	0.004	.011
Two deaths	326	0.021	—0.008	.016
Three deaths	173	0.034	0.014	.023
Four deaths	101	0.097	0.098	.030
Five deaths or more	75	—0.003	0.013	.035

*Estimated at .12 from the data.

factual deviations, the number of child deaths contributes very little to a couple's demand for contraception.

Table 9 shows that the probability of ever use for women with at most three living children, controlled for the effects of the other explanatory variables, is below the overall average rate of use. Each living child beyond the third, however, adds to the couple's demand for contraception, the net addition to the average rate of ever use reaching .18 with seven or more living children.

Table 10 describes the net effect of the age of wife on demand for contraception. It demonstrates a slight deviation from the expected inverted U-shaped relation of age of wife to demand, which is probably an artifact of the data. Women of lowest fecundity (ages 45-49), who probably did not get sufficient exposure to the concept of contraception, show a large deviation from the average rate of ever use indicating a very rare instance of use.

Associated with each coefficient in Tables 4 to 10 are the estimated standard errors which provide a measure of precision of the coefficients. In view of the number of parameters included in the analysis, the standard errors seem to indicate a fair amount of precision in most estimated coefficients. The large standard error associated with the first age category (less than fifteen) is probably due to the small number of observations in this group (only nine wives).

The regression model for the demand for contraception in Pakistan was able to explain 14.3 percent of total variance in ever use, a proportion very close to that achieved by the complementary first stage AID analysis. The large unexpalined variation is probably a result of errors in measuring the theoretical concepts represented by the explanatory vaiables as well as the fact that the model is concerned with very personal behaviour that is hard to determine.

Table 9

Estimates of Deviations from the Overall Rate of Ever Use in Pakistan For Each Category of the Number of Living Children Variable*

Number of Living Children (N_c)	Number of Cases	Unadjusted Deviation	Adjusted Deviation	Standard Error for Adjusted Deviation
No children	430	—0.097	—0.074	.020
One child	432	—0.075	—0.056	.016
Two children	433	—0.050	—0.045	.015
Three children	425	—0.015	—0.018	.014
Four children	383	0.046	0.040	.016
Five children	302	0.046	0.022	.019
Six children	237	0.113	0.094	.023
Seven children or more	248	0.201	0.178	.025

*Estimated at .12 from the data.

Table 12 presents the contribution that each explanatory variable makes to the explanatory power of the model.[7] It reveals that education of the wife, number of living children, age of wife, and level of urbanization of the place of residence each makes a highly significant contribution to demand for contraception in Pakistan; whereas the variables number of living boys, number of child deaths, and education of the husband seem to show a contribution of much lower significance. Education of the wife was the most prominent determinant of demand. The influence of the number of living children and the influence of the number of living boys are porbably deflated by the high correlation between these two variables.

Predicting Demand for Contraception in Pakistan Using the Regression Model

The estimated regression model can be used to predict the probability that a Pakistani couple, chosen at random, will have ever used contraception. The estimated coefficients associated with the couple characteristics forming the explanatory variables of the model (Tables 4 to 10) added to the estimated overall rate of ever use produce the probability of ever use. In view of the low explanatory power of the model (reasons given above), however, the error in prediction is likely to be large.

[7]For a presentation of the "Extra Sum of Squares Principle" see [16].

Table 10

Estimates of Deviations from the Overall Rate of Ever Use in Pakistan For Each Category of the Age of Wife Variable*

Age of Wife (A_w)	Number of Cases	Unadjusted Deviation	Adjusted Deviation	Standard Error for Adjusted Deviation
15	9	—0.120	—0.006	.108
15—19	334	—0.100	—0.005	.018
20—24	577	—0.038	— 0.018	.013
25— 29	615	—0.018	—0.007	.011
30—34	453	0.076	0.044	.014
35—39	457	0.059	—0.005	.014
40—44	310	0.041	—0.028	.018
45—49	135	—0.033	—0.108	.027

*Estimated at .12 from the data.

Table 11

Analysis of Variance for Regression for the Full Model with Main Effects only

Source of Variation	Sum of Squares		Degrees of Freedom	Mean Square
Regression	ESS:	119.51	32	
Error	RSS:	717.45	2857	.25
Total	TSS:	836.96	2889	

Table 12

The "Extra Sum of Squares" Contributed by Each Explanatory Variable and the Associated F Tests

Excluded Variable	Extra Sum of Squares	d_1	F	P-Value
Education of the wife	19.72	3	26.28	$P < .0005$
Number of living children	14.84	7	8.48	$P < .0005$
Age of wife	7.34	7	4.20	$P < .0005$
Level of urbanization	4.90	2	9.80	$P < .0005$
Number of living boys	2.94	5	2.36	$.025 < P < .05$
Number of child deaths	2.92	5	2.32	$.025 < P < .05$
Education of the husband	2.16	3	2.88	$.025 < P < .05$

With a binary dependent variable such as the one we have (ever used or never used), the problem arises that probabilites predicted from the regression equation may come to lie outside the range zero to one. To investigate whether this is the case with our model, we consider in Table 13 two hypothetical couples, couple A and couple B, with characteristics that have been shown by MCA to be respectively most favourable and least favourable to demand for contraception in Pakistan. Denoting the respective predicted probabilities by P_A and P_B, we have:

$$P_A = \max Pi = .12 + .83 = .95$$
$$P_B = \min Pi = .12 - .24 = -.13$$

It would seem thus that the model fails to make useful predictions for couples with certain combinations of characteristics unfavourable to demand. We note, however, that the two characteristics of couple B that have the largest negative deviations are the characteristics of no living children and age of wife over forty-five. It is very unlikely that a couple with age of wife over forty-five years would have no living children (and also no child deaths). Assuming that couple B has the average family size in Pakistan of four living children, the predicted probability of ever use becomes– .009 which is almost zero. Moreover, since both the wife and the husband are illiterate and the couple resides in a rural area, our assumption of average family size is probably conservative. The model thus does yield a valid prediction of the probability of ever use within the range of realistic couple characteristics in Pakistan.

Conclusion

We have presented above the findings of our dialogue between data and theory as regards demand for contraception in Pakistan. We conceive of our dialogue as a part of a continual process of learning about the forces that influence demand for contraception in a developing country, with the objective of contributing to the search for a solution to the population problem that developing countries in general, and Pakistan in particular, now face. In carrying out the dialgoue, we have investigated the complementary use of the two techniques of multivariate analysis—the Automatic Interaction Detector and Multiple Linear Regression. Our conclusions fall into two groups, the first methodological, and the second substantative. They are as follows:

(1) The usefulness of the Automatic Interaction Detector technique in analyzing data from large surveys is to be stressed. It provides a dynamic, efficient, description of how the explanatory variables combine to determine the dependent variable. Moreover, if the object of the analysis is to measure the net effect of each explanatory variable on the dependent variable through a multiple linear regression analysis of the data, the results of the AID analysis can be used to point to possible interaction effects that can be incorporated into a better specification of the regression model.

A condition to the use of the AID technique of analysis is, however, that the required computer equipment, and a highly trained supportive staff be available. Moreover, since the technique itself does not provide a measure of confidence in the results of the analysis, it is

Table 13

The Maximum and Minimum Estimated Deviations from the Overall Rate of Ever Use in Pakistan for Each Explanatory Variable of the Model

Explanatory Variable	Couple A (max)		Couple B (min)	
	Characteristic	Estimated Deviation	Characteristic	Estimated Deviation
Education of the Wife	10+ grades	.357	illiterate	− .013
Education of the Husband	10+ grades	.039	illiterate	− .012
Level of Urbanization	high urban	.063	rural	− .011
Number of Living Boys	3	.053	0	− .017
Number of Child Deaths	4	.098	0	− .008
Number of Living Children	7+	.178	0	− .074
Age of Wife	30—34	.044	45—49	—.108
		.832		—.243

preferable that a validation run be made on a similar set of data (or on part of the data set itself if it is large engough to allow the loss of a part) to provide a measure of confidence in the stability of the pattern of relations brought out by the AID classification.

(2) The population problem is part and parcel of the development problem. Whereas its solution can be aided by direct policies to make available a supply of contraceptive information and services, a long standing solution depends on the occurrence of changes in the social institutions that influence demand for contraception. Our dialogue has singled out particularly the education of the women, and to a lesser degree urbanization, as important policy variables that influence demand for contraception in Pakistan.

Summary

This paper is concerned with assessing the motivational forces that operate at the level of the family to create a demand for contraception in Pakistan. The variables suggested by theory as determinants of demand are the education of the wife, the education of the husband, the level of urbanization of place of residence, the number of living boys, the number of child deaths—all determining desired family size—, the number of living children, the age of wife, and the cost of contraception.

Two multivariate techniques of analysis, Multiple Linear Regression and a computerized classification analysis technique called the Automatic Interaction Detector (AID), are used to analyze the data obtained from the 1968 Pakistan National Impact Survey. The data point to the education of the wife as the most important determinant of demand for contraception in Pakistan. The number of living children is also brought out as an important determinant of demand, indicating that in Pakistan contraception is used mainly to limit births. The other important determinants of contraception demand are level of urbanization of the place of residence, and age of wife. Education of the husband, the number of living boys, and the number of child deaths are shown to have a low overall effect. There is a strong negative association between the distance from a family planning place, taken to represent the cost of contraception, and demand for contraception.

Appendix A

The Automatic Interaction Detector

The Automatic Interaction Detector technique is essentially a sequential cross-tabulation procedure. Its objective is to explain the maximum possible proportion of variance in the dependent variable, by sequential dichotomous splits of the population under study. Starting with the whole population, the AID technique splits the observations according to each explanatory variable by the dichotomous calssification on that variable which explains the greatest proportion of total variability. The technique then realizes that split, among all best splits, which has the greatest explanatory power. The procedure is then repeated in that group among the two resulting unsplit groups (and at the next step among the three resulting unsplit groups, and so on) which exhibits most variability.

The classification procedure terminates when the number of final groups or the sizes of final groups reach specified levels, or when no split on any explanatory variable of the analysis can explain more than a specified minimum proportion of total variablity (split eligibility criterion). In our analysis the maximum number of final groups was fixed at thirty, the minimum size of a final group was fixed at twenty-five observations, and the split eligibility criterion was fixed at .1 percent.

Appendix B

The Regression Model

The matrix presentation of the model is as follows:

$$\underline{Y} = Z\underline{\beta} + \varepsilon$$

where Z is matrix of dummy variable regressors and,

$$\underline{\beta} = (1, \beta_{11}, \ldots, \beta_{14}, \beta_{21}, \ldots, \beta_{24}, \ldots \beta_{71}, \ldots, \beta_{78}).$$

The variance-covariance structure of the error term is represented by $V(\varepsilon) = W^{-1}\sigma^2$, where W is a diagonal matrix with each diagonal element equal to one or to two according to whether the associated sample individual resides in an urban or a rural area.

In planning the Impact Survey, the level of urbanization was foreseen as an important contributor to differential variability in use of contraception. Denoting the rates of ever use in the urban and the rural strata by P_u and P_r respectively, our sample estimates of variability in ever use are:

(1) Estimate of $V_u(y_i)$ (variance of y_i in the urban stratum) =

$$\hat{p}_u\hat{q}_u = (.19)\ (.81) = .1539$$

(2) Estimate of $V_r(y_i)$ (variance of y_i in the rural stratum) =

$$\hat{p}_r\hat{q}_r = (.09)\ (.91) = .0819$$

We note that there seems to be twice as much variability in ever use in the urban stratum. Thus, assuming homoscedastic and uncorrelated errors within each stratum, we can denote $V_u(y_i)$ by σ^2 and $V_r(y_i)$ by $1/2\ \sigma^2$. We can then define an nxn (n = 2890) matrix of weights W with each diagonal element equal to one or two depending on whether the individual resides in an urban area or a rural area, and with all other elements equal to zero.

Because the matrix Z does not have full rank, a solution to the normal equations $(Z'\ W\ Z)\ \underline{b} = Z'\ W\ \underline{Y}$ is indeterminate. In order to obtain a determinate solution, MAC imposes the restriction that the weighted coefficients of each predictor sum to zero, that is, that:

$$\sum_j n_j\beta_{1j} = \sum_k n_k\beta_{2k} = \sum_m n_m\beta_{3m} = \sum_n n_n\beta_{4n} = \sum_r n_r\beta_{5r} = \sum_s n_s\beta_{6s} = \sum_t n_t\beta_{7t} = 0$$

MCA then applies an iterative procedure to obtain the least-squares estimator.

Because the MCA technique does not report standard errors of the estimator $\underline{b}$, we made use of the relation that exists between MCA coefficients and the coefficients from a regular dummy variable regression to obtain estimates of the standard errors. In a regular dummy variable regression the restriction is imposed that the parameter of one category of each explanatory variable is set to zero. The corresponding model is $\underline{Y} = R\underline{\beta}' + \varepsilon$. We can express the estimator $\underline{b}$ of the parameter $\underline{\beta}'$ as follows: $\underline{b} = \underline{k}\,\underline{d}$. It follows that $V(\underline{b}) = \underline{k}\ V(\underline{d})\ \underline{k}'$.

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