A MODEL OF FERTILITY BEHAVIOUR IN INDIA[1]

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Recently, Professor Bhagwati wrote that, "For a number of underdeveloped countries, there is an important choice in the use of resources for reducing the growth of population. Indeed, it is vitally necessary for countries with severe underemployment and rapidly growing populations to consider the question of population control with utmost seriousness. Unfortunately, even countries in serious population difficulties(as, for example, India) have contented themselves with cursory analysis and inadequate action in this important field."[2]

This paper is an attempt to contribute to our understanding of the factors which determine the birth rate in India. In this paper I specify and estimate a simultaneous equations model of fertility behaviour in India. The model has five equations and five endogenous variables. The endogenous variables are: birth rate, infant mortality, per capita income, dependency rate, and female participation rate. This specification allows for interdependence between birth rate and per capita income as suggested by Okun(1965); takes account of the opportunity cost of child bearing as suggested by Mincer (1963), Cain(1966), and Schultz(1969)and treats a wife's labour force participation decision as endogenous as suggested by Willis(1973).

The scheme of the paper is as follows. In Section I, I specify and discuss the model. In Section II, I discuss the data and present the results. This is followed by a discussion of the results and the multiplier analysis in Section III. The last section briefly summarizes the main findings.

I. THE MODEL

The equations of the model are as follows:

1) $BR=a_1+\overset{+}{b}_1 IMR+\overset{+}{c}_1 Y+\overset{-}{d}_1 LR+\overset{-}{e}_1 FPR+\overset{-}{f}_1 AMF$

2) $IMR=a_2+\overset{-}{b}_2 Y+\overset{-}{c}_3 LR+\overset{-}{d}_4 HE$

3) $Y=a_3+\overset{-}{b}_3 ZD+\overset{+}{c}_3 LR+\overset{+}{d}_3 KP+\overset{-}{e}_3 ZT$

4) $FPR=a_4+\overset{-}{b}_4 BR+\overset{+}{c}_4 LA+\overset{+}{d}_4 FLR$

5) $ZT=a_5+\overset{+}{b}_5 BR$

where BR* stands for birth rate, IMR* for infant mortality rate, Y* for per capita income, FPR* for female participation rate, LR for literacy rate, AMF for age at marriage of females in urban areas, HE for per capita expenditure on health services, ZD for population density, KP for per capita energy consumption, FLR for female literacy rate, LA for percentage of male labour force in agriculture, and ZT* for percentage of population below 15 years of age(dependency rate). The variables with an asterisk are endogenous while the remaining ones are endogenous.[3] The expected signs of the parameters are shown above the parameters in each equation.

Some comments are in order on these equations.

Fertility equation

This equation embodies the hypotheses put forward by Adelman(1963), Becker (1960), Mincer(1963), Cain(1966), and Schultz(1969,1973), among others. Very briefly, the inclusion of per capita income follows from the theory of consumer choice, as for example, argued by Becker. Female participation rate is included as a proxy for the, "opportunity income of women and their access to the labor market".[4] The inclusion of infant mortality is justified in terms of the replacement needs of a family for children [Gregory et al.(1972), Schultz(1973)]. The role of education has been discussed extensively in the literature and does not need any elaboration. The reason for the inclusion of age at marriage is that women marrying at an earlier age are exposed to sexual activity for a longer duration and thus the possibility of a larger number of births. Thus we would expect a negative relationship, cateris paribus, between fertility rate and the age at marriage (Driver 1963). A specific point is in order about the particular variable used in this study. The proper variable to use would have been the age at marriage of females in both the urban and the rural areas. But unfortunately the only information currently available relates to the age at marriage of females in the urban areas only. Since, however, most of India's population is still rural, where the age at marriage of females is somewhat lower, our measure most likely overestimates the actual age.

Infant mortality equation

This equation is quite similar to the one used by Adelman. The variable, per capita health expenditure, is used as an index of the availability of health care services.

Per capita income equation

In this equation, per capita energy consumption is used as a proxy for per capita fixed capital.[5] Population density is used to measure the pressure of population on non-capital resources, although this is only a rough measure as pointed out by Adelman. Literacy may be taken to represent quality of labour. As already pointed out, this model allows for interdependence between the birth rate and per capita income according to Okun's arguments. We hypothesize that birth rate affects per capita income in the following way.[6] Per capita income, cateris paribus, depends on total labour force participation rate. Total labour force participation rate, among other things,

depends on dependency rate. And as we shall argue below, dependency rate depends on birth rates. Thus our hypothesis is that high birth rates lower per capita income by leading to high dependency rate which in its turn leads to lower total labor force participation rates. A priori, therefore, we would expect a negative partial relationship between per capita income and dependency rates.[7]

Female participation rate

Birth rate affects the supply of female labour and is therefore included as an argument of the female participation rate equation.[8] It is now well recognized that labour force participation is higher in largely agrarian economies than in industrialized economies,[9] and we therefore expect a positive relationship between female participation rate and the level of non-industrial development where the latter is measured by the percentage of male labour force in agriculture. We expect the effect of female literacy rate to be positive because more jobs are open to educated women than to the uneducated.[10]

Dependency rate equation

This equation is straightforward and its rationale based on demographic theory has been ably summarized by Leff. Thus, "demographic theory indicates that a prolonged high birth rate will affect a population's age composition, placing a relatively large percentage of population in the younger age bracket".[11]

II. THE DATA AND THE RESULTS

The model was estimated by the method of Two Stage Least Squares using cross-section data for 1961 for thirteen states.[12] These were the only data that could be found for such a study.[13] The details are given in the Appendix. The 't' values are given in the parenthesis.

The results are given below.

1) $BR = 21.6412 + 0.1196IMR + 0.0364y - 0.0701LR$
(1.818) (1.249) (0.143)
$-0.0041FPR - 0.3590AMF$
(0.030) (0.065) $R^2 = 0.2213$

2) $IMR = 237.0754 - 0.2758y - 0.1284LR - 2.9850HE$
(1.558) (0.093) (0.162)
$R^2 = 0.1410$

3) $y = 108.4419 - 0.0297ZD + 5.5328LR + 0.0824KP$
(0.323) (1.621) (1.658)
$-2.1068ZT$
(0.179) $R^2 = 0.3940$

4) $FPR = -20.8348 - 1.9762BR + 1.6891LA$
(1.713) (2.361)
$+1.1258FLR$
(1.470) $R^2 = 0.4310$

5) $ZT = 16.7043 + 0.5580BR$
(7.966) $R^2 = 0.8710$

III. DISCUSSION OF THE RESULTS

In so far as the signs of different coefficients are concerned, the model must be considered a success. However in terms of the statistical significance of the coefficients and the values of R^2 the results are somewhat mixed.

In the fertility equation, only the coefficients of infant mortality and per capita income exceed their standard errors. Despite the fact that the explanatory power of this equation is low, the results are nevertheless highly suggestive. For one thing our results support the finding of a significant partial relationship between fertility and infant mortality for a large number of low income countries[14] and thus provides additional evidence for Schultz's contention that in our efforts to explain fertility behaviour, "the regime of mortality cannot be neglected in low-income countries."[15] Our results, based on highly aggregative data, which however cover the entire country, also provide support for Driver's(1963) finding of a negative relationship between age at marriage and fertility. It should be pointed out here that Driver's study was based on a sample of about 2600 households from Central India. Our results also accord with those of Gregory et al.[16] who in a two equation model of fifteen developing countries found female participation rate and literacy to be insignificant variables in their birth rate equation.

In the infant mortality equation, only the coefficient of per capita income exceeds its standard error. The other two variables are only suggestive.

The results of the per capita income equation are fairly reasonable. The unimportance of population density has also been reported by Gregory et al.(1972). The lack of significance of the dependency variable deserves special mention. In a slightly different context -- dependency rates as being a determinant of savings rate in LDC's -- I reported earlier that in very poor countries, the relation between these variables was insignificant.[17] The present result would thus appear to be consistent with that finding. An interesting thing about this simultaneous equations model should be pointed out here. That relates to the role of literacy. In single equation models, literacy influences fertility only directly as in our equation (1). However, in our model, it affects indirectly too -- through its effects on infant mortality, per capita income and female participation rate in so far as female literacy is concerned. Thus it would appear that single equation models seriously underestimate the role of education in dealing with population control.

The equations for female participation rates and dependency rate are highly satisfactory. Every coefficient exceeds its standard error.

In order to examine the impact of exogenous variables, we solved the model for its reduced form. However, since the units

of measurement are not common for all the variables, to make the reduced form coefficients comparable, using means of the variables, I converted them into elasticities. These elasticity multipliers measure the direct and indirect effects of a one per cent change in a given exogenous variable on a given endogenous variable. The results are given in Table 1. (See the Appendix for the tables).

Looking at the elasticity multipliers of the birth rate equation, the results are very disheartening. Not one of them amounts to anything. Considering literacy rate, for example, a major policy variable, we see that a one hundred per cent increase in literacy will cause a mere three per cent reduction in the birth rate. This means that even if India could achieve complete literacy -- from the present level of thirty per cent -- its birth rate will decline by no more than seven per cent. Given the fact that the present birth rate is about thirty-seven per thousand, this would hardly make a dent in the population problem. However, this is much too pessimistic a conclusion. This becomes clear when we look at the intercept multipliers in Table 2.[18] They measure the effect of the endogenous variables on the birth rate. Thus the intercept multiplier with respect to infant mortality rate is 0.71. This means that a downward shift in the infant mortality intercept of one per cent will cause a 0.71 per cent reduction in the birth rate. Thus, given the fact that the Indian infant mortality rate is about 137.0 per 1000, it would appear that there is considerable scope for reducing birth rate by reducing infant mortality. We may thus conclude from this that the role of reducing infant mortality should be regarded as a part of policies for controlling population growth and hence more attention should be paid to measures leading to reduced infant mortality.

It is interesting to compare some of the elasticity multipliers and intercept multipliers for India and the United States of America -- the only country for which such estimates are available. The relevant information is given in Tables 3 and 4.

Given the somewhat different specifications of the two models and the data used (time series for the U.S. and cross-section for India) I do not want to exaggerate the importance of this comparison. Nevertheless the differences are far too striking to be a mere coincidence. Two differences stand out rather glaringly: (a) a much more pronounced role of education in the United States than in India--all that it probably means is that the quality of education and efficiency in its use leave much to be desired in India; and (b) while there is virtually no impact of changes in income and female participation rate on birth rate in India, just the opposite is the case for the United States. In so far as the effect of infant mortality is concerned, the results for India are just the reverse of the United States. This latter difference -- (b) -- would appear to support Schultz (1973) and Gregory et al.'s(1972 arguments. It also shows that the hypothesis about the opportunity cost of women's time being a determining factor of birth rate, at least in the Indian conditions would appear to be not very strongly applicable. We should, however, emphasize that even for India we cannot dismiss it as being irrelevant because in the structural equation we did get a negative coefficient for the female participation rate, which is at least suggestive. It may well be that a separate treatment of urban birth rate will provide a stronger support for the Mincer-Schultz hypothesis.

IV. CONCLUDING REMARKS

Our simultaneous equations model captures some important aspects of India's fertility behaviour. In terms of the signs of various coefficients, the model performs quite well. In terms of the policy implications we find that literacy has a significant effect though its direct impact is very small. The best chances of reducing the birth rate would appear to be through a reduction of infant mortality where literacy plays a significant role.

Given the limitations of the data, the results of this must of necessity be regarded as tentative. It would be useful to estimate a more disaggregated model, say, for example in terms of rural-urban dichotomy. It would, of course, be highly desirable if a time series study could be carried, but this would appear to be almost impossible at the present time. The only hope of a more thorough study thus is the use of more diversified cross-section data.

APPENDIX

The data, as already pointed out, relate to the year 1961 and cover thirteen states. Thus in all there are thirteen observations. The sources are given below.

1. Data on birth rates, population, infant mortality rates, dependency rate, age at marriage of females, percentage of male labour force in agriculture, were collected from Ashish Bose (ed.), Patterns of Population Change in India 1951-61, Calcutta: Allied Publishers, 1967.
2. Data on female participation rates, literacy rates, population density, and female literacy rates, were collected from V.G. Kulkarni, Statistical Outline of Indian Economy, Bombay: Vora and Company, 1968.
3. Data on per capita income were collected from the National Accounts of Less

Developed Countries, Paris: O.E.C.D., 1968.

4. Data on per capita health expenditure were collected from the Health Statistics of India, 1962, Government of India.

5. Data on per capita energy consumption were collected from the Demand for Energy in India, 1960-1975, National Council of Applied Economic Research, New Delhi. This book provides data by end use and for various sources of energy for each state. Different sources of energy were reduced to KWH using the conversion factors given in this book and then added to give total energy consumption. Using state population as a denominator, we calculated per capita energy consumption for each state.

TABLE 1

ELASTICITY MULTIPLIERS

Endogenous Variables	Exogenous Variables						
	LR	AMF	HE	FLR	LA	ZD	KP
BR	-0.0399	-0.1457	-0.0197	-0.0016	-0.0113	-0.0012	0.0152
IMR	-0.3092	-0.0146	-0.0527	-0.0002	-0.0011	0.0298	-0.3752
Y	0.4245	0.0217	0.0029	0.0002	0.0017	-0.0443	0.5579
FPR	0.1175	0.4292	0.0580	0.5672	4.1550	0.0036	-0.0447
ZT	-0.0226	-0.0824	-0.0112	-0.0009	-0.0064	-0.0007	0.0086

TABLE 2

INTERCEPT MULTIPLIERS

Birth rate with respect to

Y	0.080
FPR	-0.002
IMR	0.710

TABLE 3

ELASTICITY MULTIPLIERS

(Effect of education)

Endogenous variable	India	U.S.
BR	-0.0399	-0.496
Y*	0.4245	1.018
FPR	0.1175	0.260
IMR	-0.3092	-2.180

*For the U.S. this relates to permanent income. The U.S. estimates are from Gregory et al.(1972).

TABLE 4

INTERCEPT MULTIPLIERS

Birth rate with respect to

Endogenous variable	India	U.S.
Y*	0.080	0.792
FPR	-0.002	-0.684
IMR	0.710	-0.086

*See footnote in Table 3. Source as for U.S. as in Table 3.

FOOTNOTES

1. I should like to thank Professor P. Krishnan for his very helpful suggestions. My thanks also go to J. Bosma, Alan Sharpe and Hugh Williams for their assistance with computations.

2. Bhagwati (1966), p. 196.

3. It is of course understood that the choice of endogenous variables to some extent is always arbitrary. Thus one could always argue that a number of other variables, like per capita energy consumption, the percentage of male labour force in agriculture, and the age at marriage should also be considered as endogenous. However, given the paucity of data and the small number of observations at our disposal, the model is not expanded to allow for additional endogenous variables. But, as shown below, the present model, by allowing interdependence between income, female participation rate, birth rate, and infant mortality rate does

throw more light on decisions relating to fertility than single equation models.

4. Schultz (1969), p.155. See also Mincer(1963) and Cain(1966).

5. See Kim(1969) for the use of such measure.

6. More specifically, the argument is as follows. Let $Q = f(K,L)$ where Q is GNP, K is capital and L is labour. Assuming a linear homogeneous production function, we get

   $\frac{Q}{N} = F(\frac{K}{N}, \frac{L}{N})$ where N is population.

   L/N is total labour force participation rate.

   Then $\frac{L}{N} = f(ZT)$ $f' < 0$ and

   $\frac{Q}{N} = F[\frac{K}{N}, f(ZT)] = F_1(\frac{K}{N}, ZT)$ and

   $F_{1ZT} < 0$.

7. See also Enke (1973) on how increasing fertility by changing the dependency rates lowers per capita income. For the use of a somewhat similar equation, see Gregory et al.(1972).

8. See Cain (1966, 1973) and Benham (1971).

9. See United Nations (1962).

10. See Farooq (1972).

11. Leff (1969), p. 887.

12. We recognize the problems of aggregation involved in the transition from the model based on the household to the states, see Gupta (1969). But to repeat these problems here would amount to no more than a ritualistic exercise, for given the limitations of the data, there is little that we can do to remedy these problems.

13. Needless to say that there are obvious objections to the use of such small sizes. But since in this case the only other alternative was that I abandon this study, I decided to proceed inspite of the limitations inherent in small samples. It should, however, be emphasized that for the less developed countries, data limitations is a chronic problem and therefore we must make do with whatever information we have.

14. Schultz (1973). He reports such an association for Bangladesh, Puerto Rico, Taiwan, Chile, and the Phillipines.

15. Schultz (1973), p. 73.

16. See Gregory et al. (1973).

17. Gupta (1971).

18. The methodology of the intercept multipliers is due to Gregory et al. (1972).

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