FERTILITY BEHAVIOR AND LABOR FORCE PARTICIPATION: A MODEL OF LEXICOGRAPHIC CHOICE

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It has been frequently observed that a smaller family size is usually associated with female employment. There is also an increasing amount of evidence that fertility rises with family income and the wife's education at relatively low levels of income and education (Encarnación, 1973, Cochrane, 1977, Hull and Hull, 1977) and only at higher levels is there the generally expected relationship that fertility falls with more education or income. Since a woman's labor force participation and her fertility are aspects of behavior of the same person (or couple), they should be explainable by a model of choice.

Section I sketches such a model; Section II cites empirical evidence and draws some implications. In particular, the model allows for a fertility decline even before a decline in mortality during the demographic transition.

I. The Model

We assume (cf. Tabbarah, 1971, Encarnación, 1973, Easterlin, 1975) that the capacity number of children a woman can bear, CK, depends positively on her educational level, E, and family income, Y:

(1) $CK = f(E, Y)$

due to better nutrition, health and medical (prenatal) care afforded by more income, and the better knowledge of good health practices and nutritional values that more education brings. We also assume that the number of child deaths in a family, CM, depends negatively on E and Y:

(2) $CM = h(E, Y)$

for reasons opposite those regarding (1). Then C, the number of (surviving) children, satisfies

(3) $C \leqslant CK - CM.$

Family income Y is[1]

(4) $Y = Y_h + t\, w\,(E)$

Where Y_h is husband's income and t w(E) is wife's income, t being her time spent on market work and w(E) her wage rate. Assuming a general-purpose commodity X with price p,

(5) $pX = Y$

is the budget constraint. We also assume that

(6) $X \geqslant g(C; E)$

is a desired minimum standards requirement that depends on family size and E, standards rising with E. In most of what follows we suppose that a couple maximizes a utility function

(7) $u(X, C, t)$

subject to (1)-(6), leaving to the end an alternative formulation. All variables are of course required to be nonnegative, satisfying natural constraints (e.g., t cannot exceed available time), and for a given couple, E and Y_h are predetermined.

Assuming that a solution to this maximization problem always exists — the no-solution case will be considered later — suppose further that

(8) $C^o = J(E, Y)$

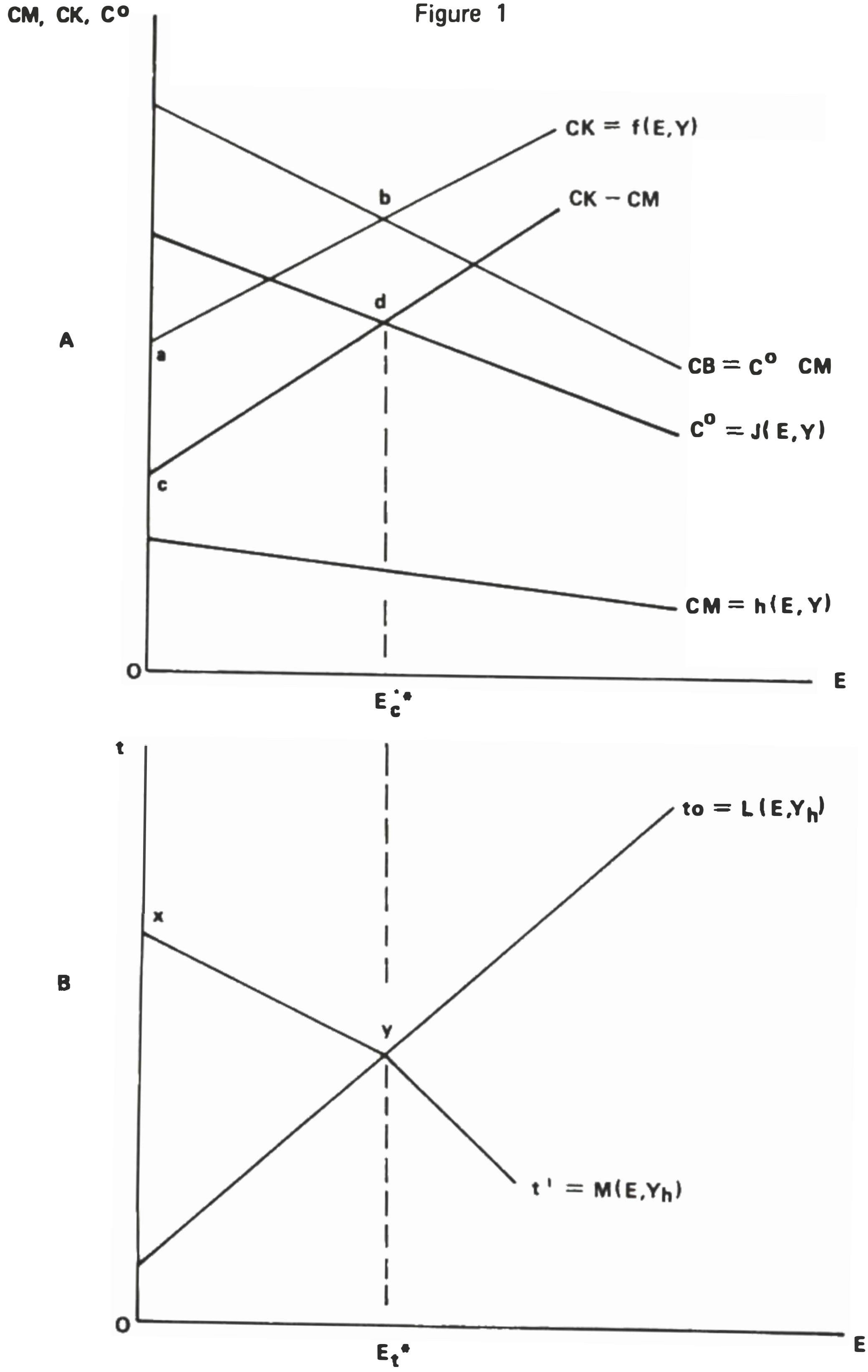
is the value of C in the solution to the same problem *without the constraint* (3). It will be useful to have a simple diagram, and for this purpose suppose that Y and E are related by $Y = k(E)$. Then we could have something like Figure IA where the CK and CM curves are drawn from (1) and (2), and the C^o curve from (8). The effect of higher E is clearly to make C^o less because of higher costs, ceteris paribus, but the correspondingly higher Y helps meet these higher costs; the C^o curve is drawn on the hypothesis that the net effect is negative.

It is reasonable to assume that a couple that would want C^o larger than CK — CM in the absence of (3) would choose C = CK — CM under (3); accordingly,

(9) $C = \min(C^o, CK - CM)$

in the solution to the original maximization problem. Thus in the diagram, what would then be observed for the number of births is

Figure 1



CM, CK, C°
CK = f(E,Y)
b
CK − CM
d
A
a
CB = C° CM
C° = J(E,Y)
c
CM = h(E,Y)
O
E
t
to = L(E,Yh)
x
B
y
t' = M(E,Yh)
O
E

the curve abCB, and for the number of surviving children the curve cdC^{o}. Below E_c*, fertility would be higher were it not for a capacity constraint.

The case C = CK — CM is one where the couple is choosing the highest C it can have compatible with (1)-(6). E and Y are relatively low, and we would expect then that (6) is binding (i.e. the constraint is satisfied as an equality). In this case, (5) is simply a relation between C and Y, while t in (4) is just sufficient for (6) to be satisfied as an equality. Let

(10) $t' = M(E, Y_h)$

be this value of t, and let

t,

(11) $t^{o} = L(E,Y_h)$

be the value of t in the solution to the maximization problem *without the constraint* (6). In order again to have a simple diagram, suppose that $Y_h = j(E)$. Figure IB is drawn on the hypothesis that t' is downward sloping and t^{o} is upward sloping, so that what would be observed for t is the curve xyt^{o}., i.e.

(12) $t = \max (t^{o}, t')$

in the solution to the original maximization problem. There is here a parallel to the situation in Figure 1A. Below E_t*, it would be less were it not for the need to meet minimum consumption standards.

We note that the corner point y of the t' curve (which corresponds to the peak C, point d in Figure 1A) lies on the curve. For at E^*_c (where C^{o} = CK — CM), we have C = CK — CM so that $t = t'$ and also $C = C^{o}$ so that $t = t^{o}$ as well. Thus E_t* (where $t^{o} = t'$) equals E_c* and we may therefore speak of an education "threshold value" E* beyond which the fertility behavior as well as the labor force participation of women become qualitatively different.

Corresponding income thresholds are defined by

(13) $Y^* = k(E^*)$

(14) $Y_h^* = j(E^*)$.

E*, Y* and Y_h* are of course not invariant since they would change with shifts in the various functions that determine them.

In the foregoing we have assumed that the problem of maximizing (7) subject to (1)-(6) has a solution, and also that such a solution satisfies (9). But income could be so low that (9) and (6) cannot both be satified. In this case we assume that (6) is dropped and (9) is maintained. (The very poor do not meet minimum consumption requirements but still have children.)

As formulated above, a couple's behavior is in effect describable in terms of lexicographical preferences; specifically, utility is a vector $U = (U_1, U_2, U_3)$ where

$$U_1 = \min(C, C^o)$$

$$U_2 = \min(X, g(C; E))$$

$$U_3 = u(X, C, t)$$

and an alternative whose utility is U is preferred to another whose utility is U' if and only if the first nonzero $U_i - U_i'$ (i = 1, 2, 3) is positive.[2] Thus the first objective is to have $C = C^o$ though in the case of below-threshold families only C = CK — CM can be reached. The second objective is to attain a minimum consumption standard, though in the case of very poor families this may not be possible. Finally, U_3 is maximized over the set of alternatives with the same U_1 and the same U_2.

II. Empirical Evidence and Implications

According to the model, fertility is a nonlinear function of E and Y with a maximum at E*, Y* so that standard linear regression estimates of the relationship between fertility and education or income would yield positive, negative, or zero regression coefficients depending on the fraction of families falling below the threshold. This would explain the diverse results that Cochrane (1977) has found in her recent review of the literature. In the Philippines, an education threshold (about 6 years of schooling) and an income threshold (the minimum wage rate) are descernible from cross-section data; see eq. (A1) of the Appendix.

An estimate of t as a function of E and Y_h is given in (A2) and, as called for by the model, the same education threshold value appears. There is thus a negative correlation between labor force participation and fertility (as is apparent from Figure 1), since both below and above E*, the two move in opposite directions. But the underlying reasons are quite different for below-threshold and above-threshold women. The latter are freely optimizing, so to speak, while the former are in the labor market simply in order to meet minimum needs. This implies that ceteris paribus, below-threshold women who have more children should be working more. (A3) is in conformity with this proposition.

The model has an important implication in regard to the fertility effects of reduction in child mortality. In Figure 1A, a downward shift of the CM curve lowers the CB curve to the same extent. Families above the threshold thus match the mortality decline fully with a reduction in fertility. The CK curve remains the same, however, and families below the threshold simply have more surviving children. The net results thus depend on the proportions of families below and above the threshold. Some countries could therefore have lower mortality for decades but still have high fertility, because of the preponderance of below-threshold families; others could experience lower mortality and then lower fertility shortly after, because of a large above-threshold majority; and we also have an explanation of the case noted by Coale (1973, p. 60) of a fertility decline even before a decline in mortality. This could come about through a shift of the C^{o} curve or through changes in educational levels.

Finally, it is obvious from the model that fertility would rise with income rising from very low levels during the early phases of economic development. Tabbarah (1971) cites a number of studies indicating that the Western European experience had been one of rising birth rates before any decline took place and that a number of LDCs today have had birth rates indeed higher than earlier.

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Appendix

The sample (size 3166) is from the Philippine 1968 National Demographic Survey, selected as single family nuclear-type households, the wife married once, and giving the required information. Let

AM = age of marriage of wife, in years
AGn = 1 if wife is in age-group n, 0 otherwise,
where n = 4 if age is 15-19 years
5 if age is 20-24 years
6 if age is 25-29 years
7 if age is 30-34 years
8 if age is 35-39 years
9 if age is 40-44 years

CEB = number of children born live
CS = number of children surviving
Em = 1 if wife has educational level m, 0 otherwise,
where m = 0 for one to four years of school
2 for five to seven years of school
3 for one to three years of high school
4 for high school graduate
5 for one to three years of college
6 for college graduate

T = 1 if wife is in the labor force, 0 otherwise
Y = family income, in thousand pesos
YH = husband's income, in thousand pesos
YHN = min (0, YH — 1.35)
YHY = max (0, YH — 1.35)
YN = min(0, Y — 1.5)
YX = max(0, Y — 1.5).

We have (t-values under regression coefficients):

$$\text{A1) CEB} = \underset{}{11.3059} - \underset{(-29.22)}{0.2877\ \text{AM}} - \underset{(-17.95)}{5.7966\ \text{AG4}} - \underset{(-33.41)}{4.5855\ \text{AG5}}$$

$$- \underset{(-27.71)}{2.9000\ \text{AG6}} - \underset{(-12.17)}{1.2666\ \text{AG7}} + \underset{(5.71)}{0.6365\ \text{AG9}}$$

$$+ \underset{(0.78)}{0.1813\ \text{E0}} + \underset{(3.38)}{0.6532\ \text{E1}} + \underset{(3.34)}{0.6853\ \text{E2}} + \underset{(2.83)}{0.6263\ \text{E3}}$$

$$+ \underset{(1.55)}{0.3625\ \text{E4}} + \underset{(1.03)}{0.2565\ \text{E6}} + \underset{(3.30)}{0.3036\ \text{YN}}$$

$$- 0.0054\ YX \quad (R^2 = 0.452)$$

$$\text{(A2)}\ T = 0.3947 + \underset{(1.60)}{0.0850\ E0} - \underset{(-0.61)}{0.0293\ E1} - \underset{(-2.49)}{0.1184\ E2}$$

$$- \underset{(-2.23)}{0.1149\ E3} - \underset{(-1.45)}{0.0796\ E4} + \underset{(7.18)}{0.4161\ E6} - \underset{(-8.02)}{0.1761\ YHN}$$

$$- \underset{(-1.75)}{0.0045\ YHX} \ (\bar{R}^2 = 0.082)$$

Both equations show E2 as the education threshold. (A1) is 2SLS, using age-group and educational level variables, AM, YHN and YHX as predetermined. (A2) is OLS, as the explanatory variables are all predetermined. (A3) below is 2SLS, from the subsample (size 2331) of below-threshold families. It seems interesting that in all three equations, the coefficients of the above-threshold income variables are not significantly different from zero.

$$\text{(A3)}\ T = 0.2280 + \underset{(4.04)}{0.1232\ E0} - \underset{(-3.44)}{0.0767\ E2} - \underset{(-7.57)}{0.1887\ YHN}$$

$$- \underset{(-0.79)}{0.0033\ YHX} + \underset{(3.55)}{0.0282\ CS} \quad (\bar{R}^2 = 0.043)$$

NOTES

[1]Family income could be defined to include children's earnings without affecting the model's qualitative results; these are left out to avoid inessential complications.

[2]See Fishburn (1974), esp. 1450-53 on "pragmatic modifications and examples," for a review of some applications of the lexicographic principle to the description of choice.

References

Coale, A.J. (1973). The demographic transition. In *International Population Conference*. Liege: IUSSP, vol. I, 53-72.

Cochrane, S.H. (1977). *Education and Fertility: What Do We Really Know*, World Bank (mimeo).

Easterlin, R.A. (1975). An economic framework for fertility analysis. *Studies in Family Planning*, *6* 54-63.

Encarnación, J. (1973). Family income, education, labor force participation and fertility. *Philippine Economic Journal*, *12*, 536-49.

Fishburn, P.C. (1974). Lexicographic orders, utilities and decision rules: A Survey. *Management Science*, *20*, 1442-71.

Hull, T.H., and Hull, V.J. (1977). The relation of economic class and fertility. *Population Studies*, *31*, 43-57.

Tabbarah, R.B. 1971). Toward a theory of demographic development. *Economic Development and Cultural Change*, *19*, 275-76.