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CONTRACEPTION AND THE INCOME-FERTILITY RELATIONSHIP

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ABSTRACT

The puzzling result that income growth is generally associated with decreasing fertility has generated a large literature. Economists have been reluctant to classify children as an inferior good and so have offered alternative explanations for the negative impact of income on birth rates. The predominant conclusion is that parental preferences are biased toward child quality, and away from child quantity, as income increases. If this very specific form of non-homotheticity exists, number of children may decline with income. In this paper, we expand the standard fertility model to incorporate child avoidance costs and the disutility of births. These additions allow us to derive a negative relationship between income and fertility without relying on any specific a priori restrictions on preferences.

CONTRACEPTION AND THE INCOME-FERTILITY RELATIONSHIP

One of the most persistent issues in economic demography is the determination of the relationship between income and fertility. Although many economists have been loath to label children an inferior good, raw data generally support the existence of a negative correlation between income and children. As Becker, Murphy, and Tamura (1990) point out, over the past century and a half, fertility has fallen as income has risen in industrialized countries. Following an initial increase in the birth rate in the early stages of economic development, the same negative impact of income on fertility is noted in most less developed countries (Simon, 1974). Moreover, cross-sectional data indicate that in a given time period, high-income families often have fewer children than low income families (Becker, 1960).

Explaining this fact has generated a large literature. The Chicago-Columbia approach has been advanced by Becker (1960), Becker and Lewis (1973), Schultz (1969, 1973) and Willis (1973) among others. The adherents of this school consider fertility to be demand determined. Parents maximize a stable utility function, in which both the quantity and quality of children enter as arguments, subject to a budget constraint. Differential fertility across time, or couples, is the result of differences in either income or the prices of quantity and quality of children but not of changes in preferences.

The Pennsylvania approach (Easterlin, 1968; Easterlin, 1975; Easterlin, Pollak and Wachter, 1980), the other predominant school of thought on the economics of fertility, also considers children to be a positive argument in the parental utility function, but puts emphasis on the formation of preferences, which they consider to be endogenous, and on natural fertility, i.e., the biological limits on child-bearing. The fundamental result in this approach is that fertility is often supply driven rather than exclusively demand determined. This is particularly likely to be the case in countries at the early stages of economic development. Easterlin, et al. (1980), claim that demand considerations are generally insignificant for low-income nations.

Both approaches to the economics of fertility predict that under certain conditions high income couples may have fewer children than low income couples and that high-income couples will invest more in each child. This is despite the fact that neither school asserts that children are an inferior good. The Chicago-Columbia model hypothesizes that parental preferences are biased towards child quality (and against child quantity) as income grows, and if that is the case the possibility of a negative relationship between child quantity and income arises. If, however, preferences are neutral, or homothetic, the negative relationship does not emerge. Thus, the negative fertility-income relationship can occur even if number of children is not an inferior good and if preferences are stable, but it is necessary to assume that preferences shift toward children's quality, and away from quantity, as income increases. This represents significant progress over the assumption that either the number of children is an inferior good or that preferences change with income. But, it is still not totally satisfactory because it is necessary to assume a specific type of bias in preferences as income increases. In a sense this places the Chicago-Columbia approach not much apart from the Pennsylvania school which assumes endogenous preferences.[1]

In this paper we present a model that integrates the cost of controlling births and the disutility of births to parents, particularly mothers, into an otherwise conventional model of demand for children. These additions offer two contributions to the important debate over the impact of income on human fertility. First, by incorporating costly contraception we show that a negative relationship between income and number of children *no longer requires a specific form* *of parental preferences*. Such a relationship can be obtained in this case even if preferences are neutral with respect to income (homothetic), or for any type of non-homotheticity.

Secondly, we extend the traditional model further by including births in the utility function, as well as child services and all other adult consumption. There are substantial physical costs associated with child-bearing, and therefore we posit that averting births will be utility-increasing. When both costly birth control and the utility effect of births are incorporated we are able to conclude that income will have an unambiguously negative effect on fertility under certain commonly assumed conditions. Once again, this result does not rely on any specific a priori restrictions on preferences. Both additions, therefore, substantially strengthen the Chicago-Columbia conclusion that fertility is likely to decrease with income assuming stable preferences.

In the following section we briefly review the Chicago-Columbia model[2], and then expand the model to incorporate costly birth aversion and the utility of child avoidance. Section II discusses the relevance of the model presented in Section I in view of available empirical evidence for developing countries. Conclusions are presented in Section III.

I. Integrating Child Avoidance Costs in a Model of the Demand for Children

Fertility models often ignore two aspects of child avoidance: the cost of contraception and the utility effect of averting births.[3] The relationship between contraceptive costs and births is perhaps considered to be trivial in developed countries because income is sufficiently high for perfect contraception to occur. For low and middle income countries, however, income is likely to be a constraint on access to birth control and, therefore, income will directly influence contraception. Further, we argue that controlling births will have a positive effect on household utility because of the large physical costs of child-bearing. The inclusion of both of these aspects of contraception greatly strengthens the argument that income and fertility are negatively related. We first present the standard Chicago-Columbia model of fertility, followed by a model that incorporates costly contraception. Finally, we present a model that further includes births avoided as an argument in the utility function.

A. The Chicago-Columbia Model of Fertility Choice

The Chicago-Columbia model strives to explain the relationship between income and fertility through changes in the relative price of quantity to quality of children. Both the income elasticity of quality and that of quantity of children are assumed to be positive. However, the income elasticity of quality may exceed that of quantity meaning that parents will purchase progressively more child quality as income increases. This raises the price of quantity relative to quality as income increases thus causing parents to substitute away from quantity. This may lead to a reduction in the number of children. The relationship between number of children and income may be negative if this endogenous price effect is strong and if certain substitution elasticity conditions are satisfied (Becker and Lewis, 1974; Becker, 1981; Nerlove, Razin, and Sadka, 1987). Although this framework assumes that tastes do not change, a specific form of non-homotheticity of preferences that shifts indifference curves toward quality vis-a-vis quantity of children as income grows is required. This generates the conclusion that increases in child quality may overwhelm the increases in child quantity generated by rising income.

The model uses a household utility maximization problem in which the household receives utility from C, child services, and Z, an aggregate commodity representing all other commodities consumed by the household (Becker, 1981). Child services represent the total amount of child quality (Willis, 1973) that is a function of Q, quality per child, and N, number of children:

$$C = C(N, Q). \tag{1}$$

The standard, and more general, form of the family utility function has N and Q as separate arguments:

$$U = U(N, Q, Z). \tag{2}$$

The utility function is maximized subject to a budget constraint, which in the simplest form is:

$$e(w, p_z)NQ + p_z Z = I, \tag{3}$$

where e is the price of child services, which is a function of wages, w, and goods prices, p_z, and I is a measure of full income. Under the assumption that the quality of children is a linearly homogenous function of parental time and other goods provided per child, the price of child services, e, is independent of N and Q. It is a linearly homogenous function of parental wages and the price of goods used in child rearing. The interaction between N and Q in the budget constraint means that the price of child quality is a function of the number of children and the price of quantity is a function of the quality invested in each child. Thus, as income expands the price of Q relative to N will change if the pure income elasticities for quality and number of children are different. In particular, if the pure income elasticity for Q is larger than that for N, the price of children's quality falls relative to that of quantity. It is this interaction that has led to the influential conclusion that although the pure income elasticity of fertility is likely positive, the observed income elasticity may be negative if certain elasticity conditions are satisfied.

It is useful to consider an equivalent linear version of the budget constraint, as follows:

$$p_Q Q + p_N N + p_Z Z = I + p_Q Q \equiv M, \tag{3'}$$

where $p_Q \equiv eN$; $p_N \equiv eQ$. Maximizing (2) constrained by (3′) yields solutions of the form

$$N^{*} = N(p_Q, p_N, p_Z, M) \tag{4}$$

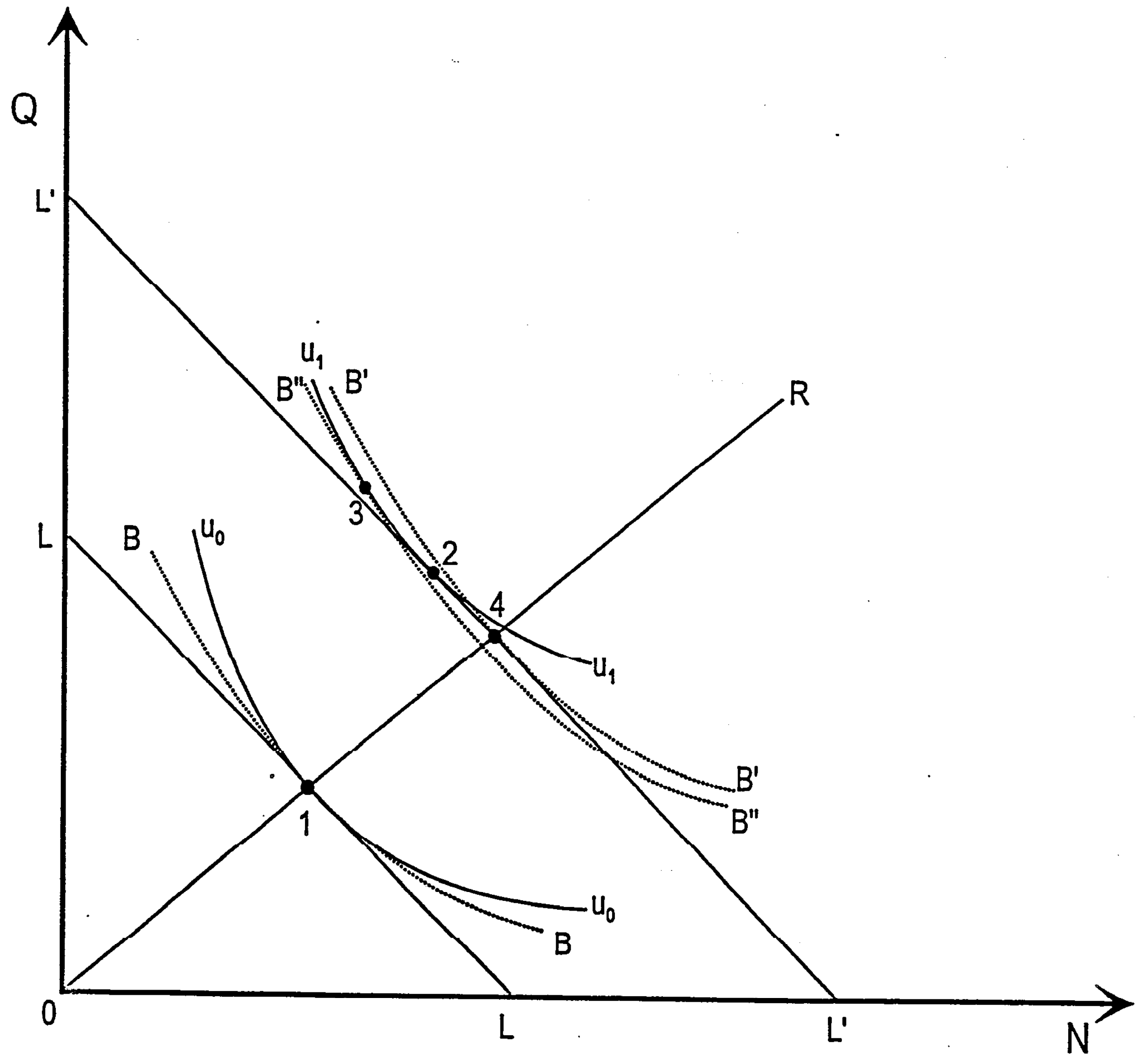
$$Q^{*} = Q(p_Q, p_N, p_Z, M).$$

The indifference map between quality and quantity of children is represented in Figure 1.[4] The original indifference curve is u_0, and the non-linear budget constraint is BB. A linear approximation of the budget constraint at the point of equilibrium is LL. The ray out of the origin, 0R, represents the linear expansion path. The initial equilibrium is at point 1.

Consider an exogenous increase in M, for the moment assuming that p_Q and p_N are fixed. This increase in income is represented by a parallel shift in the linearized budget constraint from LL to L′L′. If preferences are non-homothetic with the indifference curve shifting to the left, say to u_1, the new intermediate equilibrium will be at point 2.[5] This is because of the assumption that the income elasticity of quality exceeds that of quantity. This model does assume normality for both Q and N, so point 2 will lie above and to the right of point 1. The important thing to note is that point 2 lies above the 0R ray.

Point 2 is not the final equilibrium, because the (endogenous) relative price of child quantity to quality, $p_N/p_Q = Q/N$, increases if the income elasticity for Q is greater than that for N. This, in turn, implies substitution along the indifference curve; there is also an additional real income effect due to the fact that p_Q, Q and p_N increase. If Q and N are substitutes, as is assumed in this model and shown in Figure 1, then this change in relative prices will cause a reduction in N and a further increase in Q (point 3). The net result is an unambiguous increase in child quality and an ambiguous effect on number of children. If the substitution effect is sufficiently strong, and the income effect on N sufficiently weak, the substitution effect will dominate and N will fall.

Figure 1



This analysis relies on a specific form of non-homotheticity that shifts the indifference curves toward quality as income grows. If preferences are homothetic, the intermediate new equilibrium will occur at point 4 instead of point 2.[6] In this case there will be no price effect whatsoever and, thus, both N and Q will expand unambiguously with income. Also, if the nature of homotheticity were such that indifference curves shifted to the right instead of to the left, opposite results could arise. Admittedly this is an unlikely case, but recognizing this point underlines the strong dependence of the results on a specific form of non-homothetic biases.

B. Incorporating Child Avoidance Costs

In this section we show that by incorporating a cost of child avoidance a negative relationship between number of children and income does not require any special non-homothetic biases. Becker (1960) suggests that contraceptive knowledge may differ significantly across income groups, and that this differential knowledge is one possible explanation for the negative relationship between income and fertility. In later work, however, he rejects the importance of this effect and concludes that the answer to the puzzling connection between income and fertility lies in the interaction between quantity and quality (Becker, 1981). It is likely that this conclusion is, in part, the result of the fact that Becker is primarily interested in explaining the fertility patterns of developed countries. His later models, therefore, implicitly assume that birth-control technology is not a binding constraint in these nations which are close to "perfect contraceptive societies" (Bumpass and Westoff, 1970).

We start with the assumption that there is some natural rate of fertility, N^N, that is the fertility level achieved when no contraception is practiced. At extremely low levels of income, the consumption of goods (mainly food and health services) is so low that the couple is not likely to achieve their biological maximum number of children. They are, therefore, supply constrained.[7] As income increases, the level of consumption of goods in the household increases, and some of these goods contribute directly to an increase in the fecundity of the couple. Natural fecundity will increase with income, through the consumption of Z, until the maximum biological child-bearing capacity is reached when consumption is equal to $\bar{Z}$. After that point, increased consumption of Z will not affect natural fecundity. This relationship is expressed as

$$N^N = f(Z), \tag{5}$$

$$f' > 0 \text{ for } Z < \bar{Z}$$

$$f' = 0 \text{ for } Z \geq \bar{Z}$$

There is, therefore, a link, through goods consumption, between the ability to bear children and income at very low levels of goods consumption. This link vanishes quickly, however, as goods consumption reaches $\bar{Z}$. Since $Z < \bar{Z}$ occurs only under conditions of severe deprivation, henceforth, we assume that N^N is constant.[8]

We first ignore the utility effect of contraception and assume that each couple maximizes a single household utility function of quality of children, Q, quantity of children, N, and an aggregate good, Z, representing all other commodities that the couple consumes. This is the utility function shown in (2), and is assumed to have the standard neoclassical properties.

The utility function is maximized subject to a budget constraint:

$$eNQ + p_Z Z + \gamma A = y + w(T - L^C), \tag{6}$$

where γ is the price of avoiding a birth, A is the number of avoided births, y is non-labor income, w is the price of parental time, T is fixed total time, and L^C is the time used in child rearing. The budget constraint can be rewritten as

$$eNQ + p_Z Z + \gamma(N^N - N) = I, \tag{7}$$

where $(N^N - N)$ is avoided births, A. Maximizing the utility function subject to this budget constraint yields the first order conditions:

$$\text{(i)}\quad U_N = \lambda\,(eQ - \gamma) \tag{8}$$

$$\text{(ii)}\quad U_Q = \lambda\, eN$$

$$\text{(iii)}\quad U_Z = \lambda\, p_Z$$

$$\text{(iv)}\quad eNQ + p_zZ + \gamma(N^N - N) = I.$$

Consider a linear approximation of the budget constraint (7):

$$p_QQ + \tilde{p}_NN + p_ZZ = I - \gamma N^N + p_QQ = M, \tag{7'}$$

where $p_Q \equiv eN$, $\tilde{p}_N \equiv eQ - \gamma$. The slope of the linearized budget constraint between quality and quantity of children becomes

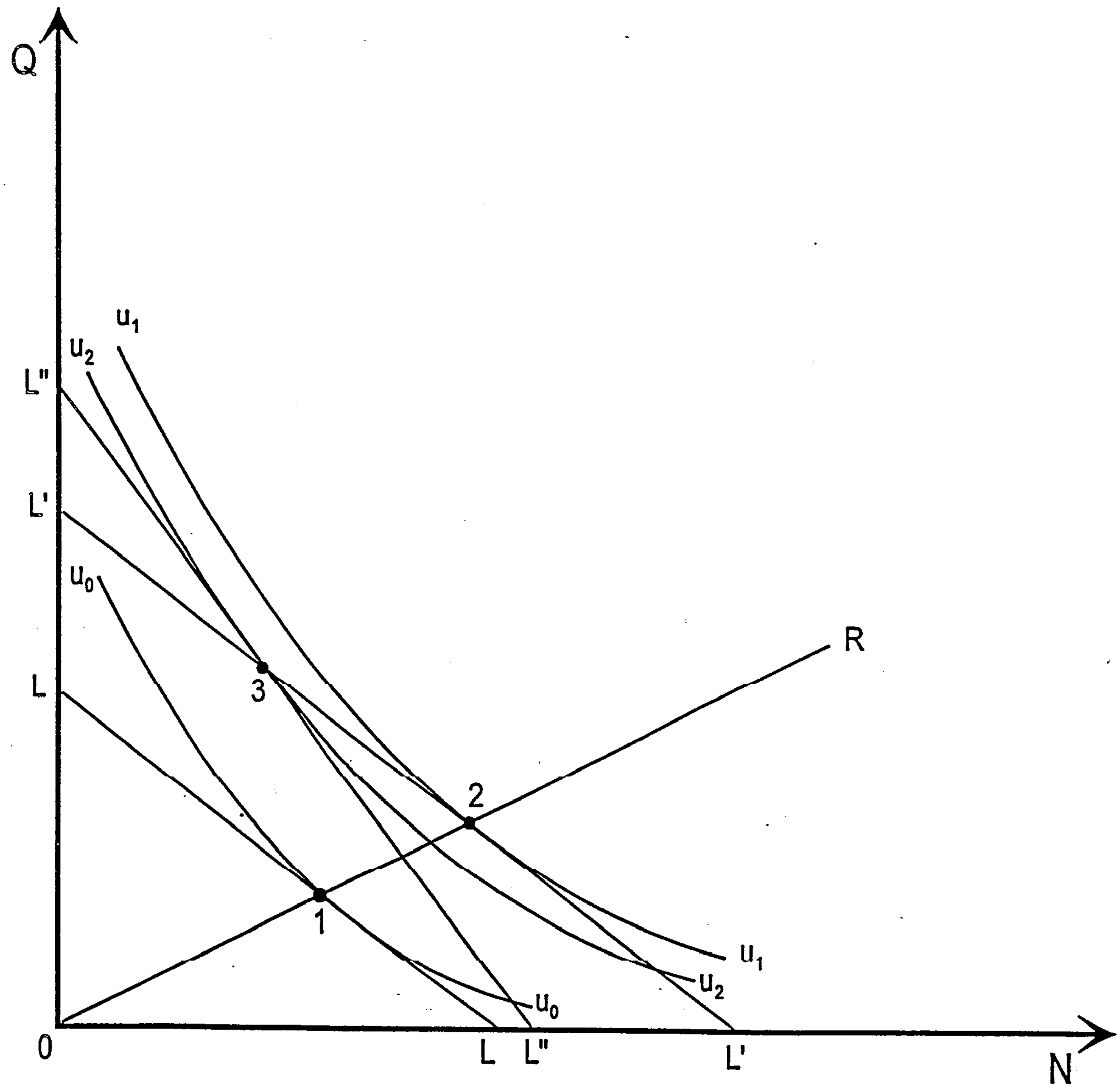
$$\tilde{p}_N/p_Q = \frac{eQ - \gamma}{eN} = \frac{1 - \gamma/eQ}{N/Q} \tag{9}$$

and we assume that expenditures per child, eQ, exceed the price of avoiding a birth, γ. Again, it is easiest to see what this implies about the relationship between income and fertility by examining it graphically.

Figure 2A assumes homothetic preferences. The starting point in Figure 2A is at point 1 where the indifference curve u_0 is just tangent to the linearized budget constraint LL. An exogenous increase in income M pushes the linearized budget constraint out to L′L′, and with no further adjustment in p_Q and p_N, the new equilibrium would be on point 2.

However, since p_Q and p_N change, point 2 is not the final equilibrium. Now the slope of the budget constraint is not simply Q/N, as was previously the case; if that were the case, with homothetic preferences as are assumed in Figure 2A, the final equilibrium would be point 2. Because of the explicit consideration of the cost of controlling births, the slope of the budget

Figure 2A



constraint does change with increased consumption of Q along any ray from the origin (i.e., for any given Q/N ratio) because it also depends on the absolute level of Q. As shown in (9), an increase in Q will increase the absolute value of the slope of the budget constraint for any given Q/N ratio. The budget constraint becomes steeper, and is represented as line L"L" in Figure 2A. The final equilibrium will be at point 3. In Figure 2A the new level of N is lower than the initial one.

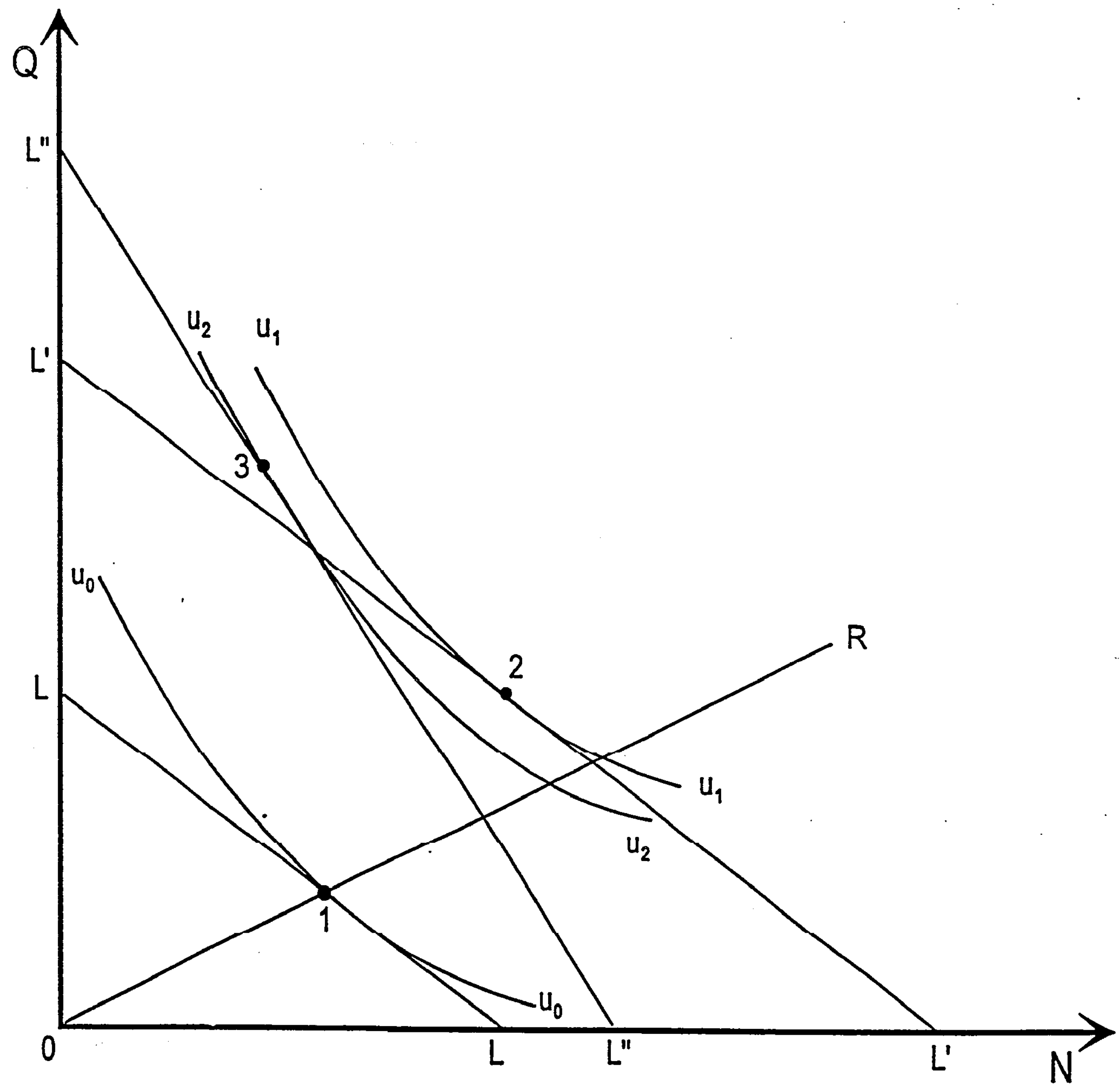
Figure 2B shows the case of non-homothetic preferences. We constructed the figure so that the non-homotheticity is in the direction of the Chicago-Columbia presumption, that is preferences are assumed to shift with income towards quality more than quantity of children. In this case, of course, the effect is reinforced. The final equilibrium, point 3, is a result of both a shift in the slope of the budget constraint and preferences that favor quality over quantity.

C. The Case of Child Avoidance and Child Services as Utility Arguments

One element missing from most previous work is the explicit consideration that fertility control may improve household well-being. While the practice of contraception may by itself be utility decreasing for psychic reasons (Michael and Willis, 1975; Heckman and Willis, 1975), the aversion of births is utility improving and this will be particularly true in developing countries. Caldwell (1983) points out that women "may incur considerable physical and psychological costs from pregnancy, childbirth, and nursing" (p.470). In addition to maternal mortality, the risk of child mortality also rises with closely spaced births (Caldwell and Caldwell, 1977; Knodel, 1983). The following analysis incorporates the utility effect of avoiding a birth.

The effect of number of children on the utility of parents is separated into two components, the usual (positive) child service effect and a negative effect associated with the

Figure 2B



number of births. The number of births is likely to have a negative utility effect on parents mostly because of the physical and psychological costs of pregnancy, childbirth, and nursing. Thus, the utility function can be written as,

$$U = U(C(N, Q), Z, B), \tag{10}$$

where B is the number of births, with $U_i > 0$ ($i = N, Q, Z$) and $U_i < 0$ for $i = B$. In order to avoid arguments with negative marginal utility we write utility as a function of children avoided, $N^N - N$, rather than of number of children born. If N^N is fixed and if the number of dead children is zero or exogenously given as we assume here, there is a one-to-one (negative) relationship between B and $N^N - N$ and, hence, we can write (10) as

$$U = U(C(N, Q), Z, N^N - N), \tag{11}$$

where $U_4 > 0$.

Additionally, we further specialize $U(\cdot)$ to make it a function of child services instead of N and Q separately. In fact, following Heckman and Willis (1975) we assume that child services $C = NQ$.[9] Thus, the utility maximization problem in this case is,

$$\max_{N, Q, Z} \; U(NQ, Z, N^N - N) \tag{12}$$
$$\text{s.t. } e(w, p_z)NQ + p_z Z + \gamma(N^N - N) = I.$$

If the household maximizes utility it also minimizes total expenditures including child related and non-child related expenses. Thus, we can define a total household expenditure function as,

$$G(e, p_z, \gamma, U) \equiv \min_{C,Z,N} \{eNQ + p_z Z + \gamma(N^N - N) : U(NQ, Z, N^N - N) = U\}. \tag{13}$$

The expenditure function $G(\cdot)$ is linearly homogenous, increasing and concave in e, p_z and γ (Diewert, 1978), and increasing in U. Moreover, using Shepard's Lemma, we obtain that

$$\text{(i)}\quad NQ = G_1(\cdot),$$

$$\text{(ii)}\quad Z = G_2(\cdot), \tag{14}$$

$$\text{(iii)}\quad N^N - N = G_3(\cdot).$$

Under the assumption of normality we have that $G_{iu} > 0$ for $i = e, p_z, \gamma$. Thus, (14) provides the levels of the endogenous variables NQ, Z and N^N - N as a function of the price variables and welfare, U. To close the model we need to determine U, which is obtained from (12) and (13),

$$G(e, p_z, \gamma, U) = I. \tag{15}$$

Thus, an increase in income I affects number and quality of children only through its effect on the level of welfare, U. (Since $G_u > 0$, it follows that $\partial U/\partial I > 0$).

The effect of I on child services, QN, is then derived from 14 (i) and (15),

$$\frac{d(NQ)}{dI} = G_{1u}\,\frac{dU}{dI}, \tag{16}$$

which is unambiguously positive given that $G_{1u} > 0$, and $dU/dI > 0$. Similarly, the effect of I on N is derived from (14) (iii) and (15). Assuming that N^N is constant,

$$\frac{dN}{dI} = -\,G_{3u}\quad dU/dI, \tag{17}$$

which is negative given that $G_{3u} > 0$. Thus, total child services necessarily increase with income while the number of children unambiguously decline. Since NQ increases, it follows that Q must increase at an even higher rate than C = NQ.

Regardless of whether preferences are homothetic or not, the same qualitative results hold as long as C, Z, and (N^N - N) are not inferior goods. With homotheticity the expenditure function can be written as $G = U\tilde{G}(e, p_z, \gamma)$ and thus $dU/dI = 1$. In fact, if preferences are biased in the way that the Chicago-Columbia model assumes, the strength of effects (16) and (17) will be even greater than if preferences are homothetic, and in the same direction. Ruling out inferiority, even if non-homothetic biases exist in the opposite direction, the effect of I on N is still negative.

Of course if preferences are specified as a more general function of Q and N the relationship between number of children and income is still ambiguous. The analysis in this section, however, helps to illustrate the importance of explicitly considering birth control expenditures as well as the likely disutility of births.

II. The Importance of Fertility Control Expenditures

The importance of the model proposed in the previous sections crucially depends on the size of fertility control costs in the household budget. If fertility control costs are a negligible fraction of the cost of a child then the model collapses into the conventional fertility model. In particular, if $\gamma/eQ \rightarrow 0$ and $\gamma B/I \rightarrow 0$ then using (7) and (9) it can be seen that the first order utility maximizing conditions become, in fact, those of the Becker and Lewis (1973). Those conditions are likely to hold for high income households and in high income countries. In developing countries, and for poor households even in industrialized economies, the cost of fertility control relative to per capita income is on average substantial. In fact, according to several recent studies the cost per averted birth in developing countries fluctuates between US $30 and US $330.[10] These costs measure only direct expenditures on contraceptives and ignore the cost of information, search and commuting to obtain contraceptives. In rural areas, in particular, these costs are likely to be significant (Bogue, 1983). In any case, even the direct costs are large for a moderately poor household in a developing countries where total expenditures rarely surpass US $2,000 per year (assuming a $2,500 per annum household income and a 20% savings rate).

There are very few estimates of the direct monetary costs of a child in developing countries. A study by Chongvatana, Manaspaibul and Hoopanich (1982) on Thailand estimates the annual cost of a child at about 19% of household income. Similarly, two studies by Glewwe (1987a and 1987b) for the Côte d'Ivoire and Peru, respectively, estimate the cost of a child at about 33% of adult expenditures. Thus, for a poor household with total expenditures of about US $2,000 per year, the annual cost of a child would be about U.S. $400 in Thailand and about US $200-250 in the Côte d'Ivoire or Peru (assuming a per capita adult total consumption of the order of US $600-750). Note that these calculations are based on gross rather than net estimates of the monetary costs per child. In most developing countries, particularly in rural areas, children are used for household and farm work from a very young age (usually without receiving any cash wage). Thus, the net cost of a child is likely to be substantially less than what the above figures suggest. On the other hand the estimated costs do not include the opportunity cost incurred due to the time allocated to child care, which in developed countries have been estimated to be as high as the direct cost. In developing countries, however, the opportunity costs are not likely to be as large (Standing, 1983).

Based on these calculations of child and contraceptive costs, the cost of birth control for a fertile couple in a developing country is likely to be in the range of 5-10% of the total annual household expenditures. Further, the γ/eQ ratio (Equation 9), which can be loosely interpreted as the cost of averting one child over the annual cost of raising a child, is likely to range from 15% to 40%. If the opportunity costs of child care are included this ratio is likely to be lower, but if one also corrects for children's economic contributions to the family and for other less measurable costs associated with fertility control one would probably obtain ratios of similar orders of magnitude.

In summary, it appears that the costs of fertility control are significant in the developing countries and, presumably for poor households in developed economies. This suggests that the model proposed is likely to be relevant in explaining fertility changes at low, and possibly middle, income levels. This may be particularly true in rural areas where the net cost of children tends to be much smaller than in urban areas. For affluent households, where birth control costs are likely to be a negligible item in the total family expenditures and as a proportion of the costs of raising children, the cost of fertility control model offers little further insight. Nonetheless, the fact that fertility control costs are substantial at lower income levels is very important because it is at those lower income levels where fertility issues are most policy relevant. It is in low and medium income developing countries where fertility levels are most sensitive to income changes. Certain empirical studies indicate that the fertility/income relation is an inverted U-shape with fertility falling at low and middle income levels and eventually starting to increase at higher income levels (Simon, 1974). The fertility control costs demand model presented in the previous section is consistent with this stylized fact.

III. Conclusions

The traditional economic model of human fertility allows for a negative income-fertility relationship if parental preferences are biased towards child quality as income increases. This is a reasonable assumption, but it is somewhat unsatisfactory that the explanation for the empirically noted negative income-fertility relationship depends so crucially on a priori restrictions on parental preferences.

A contribution of this paper is to show that this negative relationship can be derived without relying on any restrictions on preferences. We demonstrate this in two ways. First, we add costly birth control to the model. We argue that contraceptive costs are a substantial budget component in low and even middle income countries and are, therefore, likely to influence fertility outcomes. If child avoidance costs are significant, a negative relationship between household income and number of children may be present *even if preferences are completely general.*

We then further expand the fertility model by incorporating the utility effects of child-bearing. We presume the physical and psychological costs of birth are particularly large in low and middle income nations. When child avoidance is incorporated in the utility function along with child services as a single argument, *a negative relationship between income and fertility* is unambiguously obtained.

ENDNOTES

1. Warren Sanderson (1980), in his comment on the work of Easterlin, Pollak, and Wachter (1980), notes that, "the contending models [the Chicago-Columbia and Pennsylvania schools] are not nearly so different as their producers might lead us to suppose" (page 141). Pollak and Watkins (1993) make a similar point.

[redacted]

2. The economic approaches to fertility are more fully explained in Pollak and Watkins (1993) and Olson (1994).

3. One exception is Heckman and Willis (1975), in which the authors explicitly evaluate the impact of income on contraception and, subsequently, on number of births. Rosenzweig and Schultz (1985) conclude that the costs of contraception, as well as the availability of modern contraceptive technology, are potentially important in understanding the allocation of resources in households. Michael and Willis (1975) also consider contraception costs and fertility.

4. Willis (1973) presents a similar graphical analysis of the quality-quantity tradeoff.

5. Obviously, the assumption that preferences shift to the left is arbitrary but in the context of the problem is probably a reasonable assumption.

6. Indeed we are also assuming in this case that preferences for quality/quantity of children are (weakly) separable from preferences for goods. Otherwise the new implied indifference curve (not drawn in Figure 1 to simplify the graphic) would not be parallel to the original one because Z increases with income.

7. This is a common assumption. See, for example, Schultz (1981).

8. The available empirical evidence suggests that goods consumption level Z is reached at very low income levels: "Excepting under conditions of extreme nutritional stress, nutritional status does not appear to affect fecundity", is the conclusion of Dasgupta (1993, page 81) after reviewing the evidence in extremely poor countries.

9. Cigno (1991) notes that the use of child services as a single good is often invoked by authors, frequently to rule out complementarity.

10. Cochrane and Sai (1993) estimate birth aversion costs for Nepal at US $330, for Jordan at US $88, Pakistan at US $71, and Sri Lanka at US $31. A study by Molyneaux and Diman (1991) in Indonesia estimates US $49 per averted birth.

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