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The quantity/quality of children hypothesis in developing countries: testing by considering some demographic experiences in China, India and Africa*

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Abstract

Initially a general regression equation is estimated, making use of cross-country data, relating the level of the total fertility rate to a range of variables, including the level of per capita real income. There is a statistically significant negative relationship between the level of the total fertility rate and real income per capita. Once the theory of the quantity-cum-quality of children hypothesis is set out formally, and in a flexible form, it is clear that this statistical relationship is not inconsistent with this theory. However, this relationship is not a strong, or convincing, test of this hypothesis. To provide more satisfactory tests of this hypothesis, additional relevant information from various developing countries is used. Information on recent demographic changes in China provides a comparatively powerful, direct test of the theory. More indirect tests of the theory are provided by drawing on data for India in the 1960s, and for sub-Saharan African countries in the 1980s and early 1990s. These various tests suggest that the quantity-cum-quality hypothesis, in its flexible form, appears to explain some of the changes in fertility rates observed in various developing countries in recent decades.

The quality-cum-quantity of children hypothesis states that as the real income that a couple receives increases they invest more resources into increasing the quality of the children they have acquired instead of allocating these resources to acquiring more children. This assumption has been called upon to explain, in part, a constant relationship that has been observed during the demographic transition experienced by many communities; namely, that the level of the total fertility rate (TFR) for a community tends to fall as the level of mean real income for this community rises. This relationship tends to be confirmed by recent cross-country data on the total fertility rate and mean real incomes measured at international prices. As is shown in the next section, based on these cross-country data and after allowing for a range of other relevant considerations, there is a statistically significant negative relationship between the total fertility rate and appropriate measures of mean real incomes. The existence of this relationship is not, however, direct confirmation of the quality-cum-quantity of children hypothesis. What is more, there are alternative statistical results to be found in the relevant literature which imply that the quality-cum-quantity of children hypothesis may not explain any of the variation to the TFR across communities.

In the attempt to resolve this matter attention first turns to considering some appropriate theory of household behaviour. When this theory is set out in a comparatively general and flexible form, to allow for a range of considerations, it becomes clear that the observed statistical relationship mentioned in the previous paragraph could be explained by either the quality-cum-quantity of

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children hypothesis; or the assumption that the various costs to mothers when acquiring children—in the form of income forgone in bearing and caring for children—increase as the level of real income in the community rises; or by a combination of these theories.

A search needs to be made for additional empirical evidence which provides a much more direct test of the quality-cum-quantity of children hypothesis. Above all, information needs to be found which records the reasons why couples, in developing countries in particular, decide to acquire, or not to acquire, additional children. Fortunately, just such information has become available as a result of the careful surveying (carried out over the 1980s and early 1990s) of the inhabitants of three villages in central China in which comparatively rapid economic change also took place. This survey information is discussed below; it tends to support the view that, if certain circumstances apply, then the quality-cum-quantity of children hypothesis is satisfied. To provide a further test of this hypothesis some relevant information from India for the 1960s is also briefly considered. This information is not completely satisfactory, however, since it only allows certain relevant behaviour to be inferred from certain broad empirical facts; it does not provide direct recorded observations of relevant behaviour.

The statement of the relevant theory of fertility also indicates that under quite reasonable sets of circumstances the quality-cum-quantity of children hypothesis, and the opportunity-cost-for-mothers assumption, may be comparatively weak factors in explaining variations in the TFR. In these circumstances there is likely to be a positive, not a negative, relationship between the level of the total fertility rate and the level of mean real income in a community. This insight suggests an alternative test of the general theory developed in the third section: a test which takes the form of first finding those situations where most households in the community are likely to invest comparatively few resources in the quality of their children. It remains to determine if there is a positive statistical relationship between the total fertility rate and mean real income within a community, or across communities. If this is so then this provides an additional partial test of the quality-cum-quantity of children hypothesis. This approach to the testing of this theory is performed by reference to data covering the late 1980s and early 1990s for a range of sub-Saharan countries.

A number of general implications follow from the various arguments developed here. These implications are mentioned as part of the concluding comments.

Some aggregate empirical evidence on the demand for the number of children

In Figure 1 the total fertility rate (TFR) in 1992 for 95 developing countries is plotted against the respective 1992 measures of gross national product per capita (measured in United States dollars at 1992 international prices). The gross national product per capita for country i is denoted by (GNP_i/n_i).[1] The fitted ordinary least squares regression based on this information is the following:

$$TFR_i = \underset{(17.582)}{7.25} - \underset{(-8.739)}{1.424} \log (GNP_i/n_i), \quad \text{adjusted } R^2 = 0.485, \qquad \textbf{(1)}$$

where the figures in brackets denote the t-statistics. Both coefficients in this regression equation are statistically different from zero (at the one per cent level of significance).

On consulting Figure 1, however, it is reasonably obvious that other factors are at work explaining differences in TFRs across countries. One such factor appears to be cultural differences across nations. To test for this possibility a dummy variable, denoted by D_1, is used to distinguish those countries in North Africa, the Middle East and South Asia (but not Bangladesh and countries in South-East Asia) in

[1] The data are taken from World Bank (1994:212-213, 220-221).

which devotion to Islam is the dominant religious faith. Another dummy variable, denoted by D_2 , is employed to distinguish those countries in sub-Saharan Africa.

Besides this cultural consideration, intuition suggests that one other factor which may assist in explaining the variation in the TFR across countries in 1992 is the level of well-being, not just the measure of mean income, to be found in the communities concerned.[2] A measure which may be thought to come near to what is required to measure community well-being is the Human Development Index for 1990 (See UN 1990). While this index is certainly not ideal, and has been severely criticized for inaccurately measuring the level of community well-being (e.g. Das Gupta 1993), this variable may be accurate enough for the present purposes. Above all, the Index does incorporate measures of life expectancy at birth, literacy rates and, to some degree, the level of income poverty to be found within communities, all variables which could be considered for inclusion in a measure of community well-being.

Another variable that also may be considered relevant within the present context is the level of family planning effort. Here use is made of the Mauldin and Ross (1991) index for family planning effort for various countries for 1989 (see also Ross and Mauldin 1994).

Since cross-section data are being used to estimate the relevant regression equation, heteroskedasticity may be present in the estimation.[3] To avoid this difficulty use is made of the White (1980) method in the estimation of the following regression equation:

$$\begin{aligned} TFR_i = {} & \underset{(10.951)}{9.557} - \underset{(-3.890)}{0.709} \log (GNP_i/n_i) + \underset{(2.527)}{0.888} D_{i1} + \underset{(2.362)}{0.535} D_{i2} \\ & - \underset{(-2.729)}{0.623} \log HDI_i - \underset{(-6.331)}{1.113} \log FPE_i , \qquad \textbf{(2)} \\ & \text{adjusted } R^2 = 0.77, \quad n = 68, \end{aligned}$$

where the figures in brackets denote the t-statistics.

All the estimated coefficients in equation 2 have the expected sign and are statistically different from zero at the 2 per cent, or less, level of significance. Certainly the statistical results reported in equation 2 are as satisfactory as those to be found in a number of comparable studies which also attempt to explain variations in the level of the TFR, or changes in the level of the TFR, across countries: studies such as those by Bongaarts (1992), Schultz (1994), Heerink (1994:135-136, 345-346), Barro and Sala-i-Martin (1995:453-455), and Subbarao and Raney (1995). The variables used in these alternative studies are rather different, however, from those referred to in equation 2. This observation implies, therefore, that modifications of what appear to be a reasonable specification of

[2] In Martina (1995) is a discussion of the theory underpinning this intuition—a discussion based on the theory of uncertainty.

[3] This possibility means that the estimates of the standard errors may be biased. See, for example, Greene (1993).

Figure 1
1992 total fertility rate against 1992 GNP per capita at international dollar prices

the regression model may have the consequence of producing quite different empirical results (cf. Ahlburg and Diamond 1993:180).

To emphasize this point further, attention concentrates on the variable of most interest here; namely, gross national product per capita, or just mean income. The coefficient for the logarithm for this variable set out in equation 2 has a negative sign and is strongly statistically significant from zero. Yet in the study by Subbarao and Raney (1995), for example, where emphasis is placed on the provision of female education, the coefficient for mean income takes a comparatively small negative value and is not different from zero at the standard levels of statistical significance. In contrast, the positive coefficient for female enrolments in secondary school is statistically different from zero at comparatively high levels of significance.[4]

In recognition of the possibility that the level of female and male education may be of importance in explaining variations in TFRs across countries, a number of measures of these variables were used in an extended version of equation 2. The coefficient estimates for these variables (which are not shown here) were not different from zero at reasonable levels of significance. All the other variables referred to in equation 2 remained statistically significantly different from zero, however. (It should also be pointed out that a measure of literacy rates is included as part of the measure of the HDI; thus a measure of female education levels has been allowed for in equation 2)

These conflicting results suggest, therefore, that there is a range of difficulties associated with attempting to explain variations in the TFR across countries. Without going into detail, one such difficulty is that the regression estimates referred to in equation 2 almost certainly suffer from simultaneous equation bias since a number of the variables on the right-hand side of that equation almost certainly are endogenous, not exogenous as implicitly assumed in that equation.[5] Similar remarks also may be made concerning the comparable studies referred to earlier. But probably the more serious problem is that of multicollinearity which results from various relevant variables, or sets of variables, being highly correlated (cf. Johnson 1994:506-507). As a consequence it is difficult, if not impossible, to distinguish the separate influences, for example, of the level of mean income, and the level of female education on the level of the TFR. When the regression equation is specified in one form, then only one of these variables is statistically significantly different from zero. On re-specifying the regression equation to take a different, but reasonable, form, then only the other variable is of significance.

Bearing this last point in mind, the results set out in equation 2 suggest, tentatively, that an increase in the level of mean income in a developing country will assist in reducing the level of the TFR in this country. This qualified finding is consistent with the view that as the level of mean real income in this country rises so couples shift their preferences away from desiring more children and towards increasing the quality of the children already part of the household. But this inference is not the only one that could be drawn. As the discussion in the previous two paragraphs suggests, if the level of female education is highly correlated with the level of mean income, then changes in the level of fertility alternatively could be explained by changes in the level of female education which, in turn, implies changes in the opportunity cost of time for mothers bearing and caring for children. This increase in the level of this opportunity cost induces couples to reduce the level of the size of the family they want.

To gain some guidance on how to determine the importance of these two variables in influencing the level of the TFR, attention turns to considering relevant aspects of the theory of household

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[4] Barro and Sala-i-Martin (1995) also found that female, and male, years of primary and secondary schooling were statistically significant variables in explaining the level of the TFR across countries.

[5] For example, while the level of mean income is likely to influence the level of the TFR, the direction of causation may also go in the reverse direction to some degree: the level of the TFR influences the level of mean income. To handle the associated simultaneous equation bias problem use could be made of instrumental variables (see, for example, Greene 1993). The difficulty is that of finding a suitable instrument variable.

behaviour, specifically, that part of household behaviour which bears on the factors that motivate couples to control the size of their families.

Non-linear budget constraints and the demand for children

The theory developed here does not profess to be complete. In particular, the important issue of how the presence of uninsurable uncertainty may influence a couple's decisions concerning desired family size is discussed elsewhere (Martina 1995).

The fundamental assumption imposed in developing the relevant theory of family behaviour in this section is that the objective that governs the representative couple, in altering their decisions concerning family size, is that of maximizing their level of well-being.[6] The measure of well-being that a representative couple is assumed to adopt reflects, to some degree, altruism, since the couple is concerned with the quality, q, of the children they acquire. Parents expect the resources expended on maintaining and improving the health and education of a child to allow this child to lead a more fruitful life. These expenditures may not be made for purely selfless reasons: this child may subsequently earn a higher income (compared to the situation where these expenditures were not made) from which the parents hope to benefit; but the act of making these expenditures implies that the parents have choices to make. They have to choose between investing a given endowment on increasing the number of children in the household, or investing this endowment in activities that are required to develop the quality of the children already part of the family, or just expending this endowment on other goods and services. These expenditure choices imply that the couple is faced with a non-linear budget constraint. This fact raises certain complications since expenditures on the quantity and quality of children may interact in complex ways. To demonstrate this general idea more formally some relevant theory is developed here which draws on Becker (1991), as well as Becker and Lewis (1973), Rosenzweig (1990) and Razin and Sadka (1995:Ch. 3). The way this theory is developed is rather different, however, from that to be found in these various sources.

It is assumed that the model takes the following basic form:

$$\text{maximize } u(n, q, z) \text{ subject to (s. t.) } p_c qn + p_z z = Y, \qquad \textbf{(3)}$$

where u(.) denotes the direct utility, or well-being, function for the representative household, n denotes the number of children, q denotes the quality of these children, p_c, denotes the cost, or price, associated with acquiring an extra child, z denotes the amount of some composite good and p_z the price of this good. The term Y denotes the income available to be expended on these goods. No savings take place. The direct utility function is assumed to possess a range of standard properties such as being continuously increasing, and differentiable, in all arguments and quasi-concave. At a later stage additional concepts, or complicating factors, are touched upon, briefly, within the context of the optimizing problem set out in equation 3.

As it stands equation 3 is not in a form which is amenable to easy manipulation. To facilitate matters it is assumed that the optimization problem has been solved[7] and the budget constraint is linearized around the optimization consumption points. Specifically:[8]

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[6] This is not to say that all couples are always capable of maximizing their level of well-being in the process of acquiring children; some certainly make mistakes. Nevertheless, even for the couples who make mistakes the attempt to maximize their level of well-being may still be the basic principle governing their behaviour at the margin.

[7] In the optimization problem set out in equation 3 it needs to be assumed that, in the quality-quantity of children space, the non-linear budget line is less convex from below than that for the indifference curve for the utility

$$v(\pi_n, \pi_q, p_z, R) = \max \{ u(n, q, z) \text{ s. t. } \pi_n n^* + \pi_q q^* + p_z z^* = R\}. \qquad \textbf{(4)}$$

where the locally optimum consumption points are n*, q* and z* respectively. The linearized budget constraint is constructed by taking the non-linear budget constraint for Y, and rewriting it as follows: $R = Y + p_c qn$, where R denotes the locally linearized budget level. The indirect utility function in equation 4 is assumed to possess a range of standard properties such as being continuously differentiable in all arguments and so on. The indirect utility function set out in equation 4 can now be exploited to determine the form of the uncompensated, or Marshallian, demand function for the number of children; namely,[9]

$$n = f_n(\pi_n, \pi_q, p_z, R). \qquad \textbf{(5)}$$

It is from this point on that the further manipulation of equation 5 allows a deeper understanding of the empirical information presented in the previous section. In that discussion the level of mean income varied across countries. To represent that fact here the demand function for n, set out in equation 5, is differentiated totally with respect to the non-linear income level. Remembering that $R := Y + p_c qn = Y + \pi_n n$, it is shown in appendix A that:[10]

$$\frac{dn}{dY} = \left[s_{nn} \frac{\partial n}{\partial Y} + s_{nq} \frac{\partial q}{\partial Y} \right] + \frac{\partial f_n}{\partial R} \qquad \textbf{(6)}$$

In this equation the term s_{nn} denotes the compensated change in the level of demand for n as a result of a change in the shadow price for n, and the term s_{nq} denotes the compensated change in the level of demand for n as a result of a change in the shadow price for q.[11]

Before discussing the properties of this last equation it is useful to decompose the changes in the shadow prices, π_n (:= $p_c q$) and π_q (:= $p_c n$), where it is noted that p_c may also vary in size as Y changes in size. Thus equation 6 can be rewritten as follows:

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function it supports. This assumption is required to ensure that the equilibrium point is unique and stable. See Becker (1991:147) on this point.

8 For a discussion of linearizing, locally, non-linear budget constraints see Blomquist (1989).

9 To establish the statement in equation 5 it is noted that the optimization problem set out in equation 4 implies the following:-$[\partial v(\pi_n, \pi_q, p_z, R)/\partial \Xi_n] = n$. This statement implies that Roy's identity is being applied. See, for example, Deaton and Muellbauer (1980) for a discussion of this theory.

10 The derivation of equation 6 in an appendix obtainable from the author draws on certain ideas to be found in Blomquist (1989).

11 In these compensated demand functions the level of income is varied in order to maintain the initial level of well-being when prices change.

$$\frac{dn}{dY} = p_c \left\{ s_{nn} \frac{\partial q}{\partial Y} + s_{nq} \frac{\partial n}{\partial Y} \right\} + \left[q\, s_{nn} + n\, s_{nq} \right] \frac{\partial p_c}{\partial Y} + \frac{\partial f_n}{\partial R} \qquad \textbf{(7)}$$

This result represents, formally, the main set of ideas considered throughout this discussion.

Equation 7 indicates that a change in the level of real income for the representative household influences the demand for the number of children along three channels. Starting on the far right-hand side of equation 7, the term, $(\partial f_n/\partial R)$, denotes the standard income effect. Assuming that children are a normal good then a rise in the level of income (in the locally-linearized budget constraint) will result in a rise in the number of children desired, or demanded.

Turning to the set of terms in the middle of equation 7, the term, $(\partial p_c/\partial Y)$, reflects the change in the immediate costs of acquiring children as the real income varies for the representative household. This particular term will take a positive value if, for instance, at least some of any extra household income is generated by the mother in the household working for a wage in the labour market and, thereby, receiving additional income. In this instance a positive value for $(\partial p_c/\partial Y)$ would reflect the increasing opportunity cost of acquiring children as the income received by the mother in the family increases.[12] In empirical work relating to this matter the usual procedure, however, is simply to represent these opportunity costs with the proxy variable:some suitable measures of the education level attained by females in the community concerned (e.g. Barro and Sala-i-Martin 1995:452-453; Schultz and Zeng 1995; Subbarao and Raney 1995).

As for the set of terms in square brackets in equation 7, under a reasonable set of assumptions[13] it can be shown that these terms must sum to a negative value. Thus the product of the two sets of terms in the middle of equation 7 must take a negative value if $(\partial p_c/\partial Y) > 0$. This result represents the argument that the number of children demanded by the representative household must decline if the opportunity cost of acquiring children rises as the income for the household rises. This result is to be expected and is not inconsistent with some of the empirical results referred to in the previous section.

The third set of terms set out in curled brackets in equation 7 represents the consequence of the representative household being faced with a non-linear budget constraint. The presence of this

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[12] The argument sketched out in the main text could be extended to include the point, made by Easterlin (1980) and Butz and Ward (1978), that a rise in aggregate real incomes implies that a wider range of goods has been created upon which households may expend their income. Thus to expend extra income on acquiring an extra child is to forgo the opportunity to consume this growing range of goods available.
In addition the term p_c in equation 7 in the main text could be extended by taking into account a range of relevant considerations. For instance, allowance could be made for:(i) the time, denoted by $L_c(Y)$, devoted to bearing and caring for children; (ii) the market wage, denoted by w_f, paid the mother in the household, and (iii) the costs of medical services, denoted by $p_{mc}(Y)$, associated with bearing and raising children. Now the term p_c is stated in the functional form: $p_c = \phi(w_f(Y), L_c(Y), p_{mc}(Y))$. Totally differentiating this function with respect to Y, the result could now be substituted back into equation 7 in the main text to give an expanded version of that equation.

[13] These assumptions are that the compensated demand function for the number of children is homogenous of degree zero in all prices, and that n (the number of children) is a pure substitute for z (the composite good). The homogeny assumption is a basic one in the theory of demand; see, for example, Deaton and Muellbauer (1980). The assumption that n and z are pure (compensated) substitutes implies that, at a fixed level of household well-being, as the price of z rises the demand for n also rises. This would seem to be a perfectly reasonable assumption to impose.

constraint implies that the two sets of terms in curled brackets will interact with one another. As an example to illustrate this process, suppose that, in the initial situation, there is an increase in household income generated by the introduction of new technology and new market opportunities. To take more advantage of these new economic opportunities in the future the representative household recognizes the need to invest more in the quality of the children. Thus the term, $(\partial q/\partial Y)$, takes a positive value.[14] This action also implies that the value of the relative shadow price ratio, π_n/π_q must also rise (remembering that $\pi_n := p_c q$, and $\pi_q := p_c n$). The increase in this price ratio, in turn, will induce this household to demand, or desire, fewer children, other things remaining the same. Thus the term, $(\partial n/\partial Y)$, will take a negative value. This change will induce yet a further rise in the price ratio, π_n/π_q, which, in turn, may induce yet further investments in the quality of children. If these investments do take place, and the price ratio, π_n/π_q, changes accordingly, then the interaction process will continue. The point where it will stop is that where the representative household sees no further advantage to be gained by investing more in the children in the household.

Next it is noted that the term, s_{nn}, must take a negative value[15] and the term, s_{nq}, is assumed to take a positive value. When these conditions are combined with the previous assumptions that the term, $(\partial q/\partial Y)$, takes a positive value and that the term, $(\partial n/\partial Y)$, must take a negative value, then the sum of the terms in curled brackets in equation 7 must take a negative value.

This illustration of the interaction effect suggests a number of implications. The first is that the type, or form, of the growth of household real income will influence the size of the interaction effects. If this growth is of a form which causes couples to see no advantage in investing more in the quality of children – say this growth is the result of improved weather conditions over a sustained period of time – then the sum of the terms in curled brackets in equation 7 will tend towards taking a value of zero. (The same point could be made with respect to the middle set of terms in equation 7, the opportunity cost terms.) If, on the other hand, the form of economic growth is quite different, and induces households to invest in the quality of children, then it is possible that relatively large interacting changes may be induced by the initial stimulus. Following this last point, it would not be legitimate to assume that the initial stimulus caused the complete, interacting, change. Rather the complete change is the result of a process of interacting variables.[16]

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[14] Again, at this point in the discussion, a more detailed argument could be provided by considering the benefits and costs associated with investing in the quality of children. To represent this idea it is assumed that $q = \varphi(p_s(Y), r(Y))$, where p_s denotes all the costs (including any opportunity cost of the time spent on formal schooling) associated with providing more schooling to a child in the household, and r denotes the rate of return on any investment in the quality of a child. If the way in which the growth in household income takes place indicates that the return on investing in the quality of a child is likely to be greater than the cost of this investment, then the term $(\partial q/\partial Y)$ in equation 7 in the main text will tend to take a positive value. If this is not the case, then this term will tend to take a value of zero. Again these ideas could be explicitly represented in an expanded version of equation 7.

[15] This assertion is an implication of the assumed quasi-concavity of the direct utility function.

[16] This last point has implications for determining the influence of a family planning program. Suppose an increased family planning effort (E) induces couples to reduce the level of demand for the number of children. This initial change, denoted by $(\partial n/\partial E) < 0$, will alter the shadow price ratio in such a way that couples now see advantage to be gained by investing more in the quality of children. This change in behaviour, denoted by $(\partial q/\partial E) > 0$, may induce yet further falls in the demand for the number of children, and so on as these two terms interact. It would not seem legitimate, however, to assign the whole of the fall in the demand for n, denoted by $\Delta n < 0$, to the

To draw together this discussion of the three sets of terms to be found in equation 7, it is noted that the sign of that equation is not immediately obvious, even if quite detailed information is available. For instance, if the community concerned experiences a growth in real mean income which creates new employment opportunities for women and requires the application of more skilled labour, then the first two sets of terms on the right hand side of equation 7 will take negative values. The third term in that equation will take a positive sign value if the number of children is a normal good. Another way of explaining this indefinite outcome is to note that the growth in real mean income in the community influences, simultaneously, both the demand and the supply side of the market for the number of children. While the increase in the level of real income in the community increases the level of demand for the number of children, this change may also be accompanied by changes, such as the introduction of new technology and the creation of more jobs for women, which also raise the supply price (the marginal cost) of acquiring an additional child. The equilibrium outcome of these offsetting changes is not immediately obvious.

To explain matters a little further, this idea is represented in the partial equilibrium diagram set out in Figure 2 which represents the market for the number of children. The demand function, $f_n(\pi_n, \pi_q, p_z, R)$, for the number of children is drawn in the space where the number of children, n, is set against shadow price for number of children, π_n (:= $p_c q$). The marginal cost, or supply, curve for the number of children is represented by the level of the shadow price for the number of children, π_n, at each level of the number of children. This supply curve for the number of children in Figure 2 reflects the assumptions that:(a) the marginal cost of an extra child, denoted by p_c, remains constant, and (b) the quality of any child is assumed to be constant, as the number of children increases. Relaxing these assumptions does not alter the general result to be derived here.

The initial number of children demanded, or desired, is that where the demand schedule at the locally linearized income level, R, intersects the marginal cost, or supply, schedule at this income level. This equilibrium number of children demanded is represented by the distance On_o in Figure 2. Next there is an exogenous increase in the level of income. The demand function for the number of children shifts out to $f_n(\pi_n, \pi_q, p_z, R')$. This results, initially, in the equilibrium level of demand for the quantity of children rising from On_o to On_2.

If there also is a rise, however, in (a) the demand for the quality of children and (b) the opportunity cost of acquiring an extra child, then the shadow price, or marginal cost, for the number of children must also rise. This implies that the supply schedule for the number of children must also shift upwards to, say, the level represented by schedule marked $p_c q(R')$ in Figure 2. This new supply schedule is taken to represent the end, or long-term, consequence of the interaction between the quality and quantity of children effects. As represented in Figure 2, the resulting rise in the costs associated with acquiring and maintaining children is large enough to ensure that the equilibrium number of children demanded at the end of the adjustment period (represented by the distance On_1) is less than the number initially demanded (represented by the distance On_o). Naturally, matters need not have turned out like this. The supply schedule may have risen by a much smaller degree, relative to the right-ward shift of

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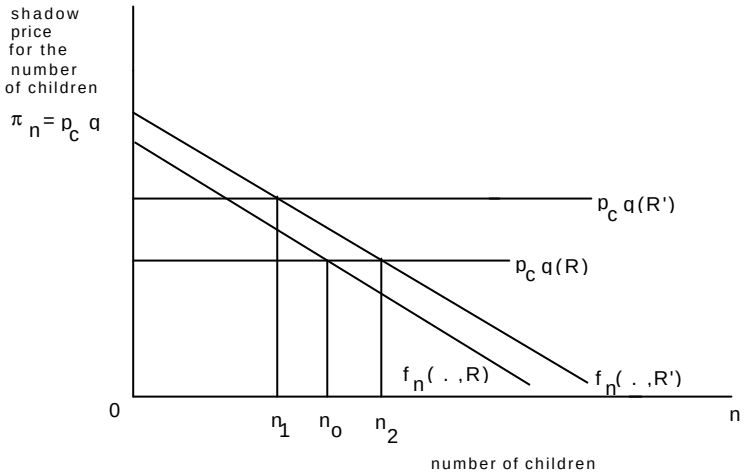
increased family planning effort. This point has been emphasized by Becker (1991:151) when commenting on observed changes in the TFR:

> Although family planning might take credit for the whole decline in births because it is the initiating force, the induced increase in the demand for higher-quality children and the induced decrease in the demand for quantity of children are responsible for more than half of the decline of births.

the demand schedule, so that the equilibrium number of children demanded remained unaltered, or actually rose.

Figure 2



This simple example implies that it may be difficult to determine, from *a priori* reasoning alone, the relative position of the final equilibrium level of the demand for the number of children resulting from an increase in the level of mean real income in a community. Nevertheless, there may be circumstances where, based on additional information, it may be reasonable to deduce that the equilibrium level of demand for the number of children will fall as a consequence of a rise in the level of real income per capita in the community concerned. For instance, this rise in mean real income may be the consequence of (and future rises in real income can only be sustained if there are) much increased levels of investments in human beings, and especially investments in the education of children.[17] That being the case, then parents are likely to begin to alter their preferences away from acquiring more children and towards increasing the quality of the children they have already acquired.

In contrast, however, consider the situation where the growth of mean real income is the consequence solely of the expansion of the natural resource base (say new and major deposits of a precious mineral have been found), or an improvement in the terms of trade facing households in rural communities in developing countries. In this situation there is likely to be only an increase in the demand for the quantity of children; the demand for the quality of children will tend to remain unchanged. Thus the supply function in Figure 2 remains fixed in this case, and only the normal income effect applies.

These contrasting situations demonstrate a point made earlier: that the way increases in mean real income in a community are generated may well have an important bearing on whether this economic growth will result in a rise, or a fall, in the level of demand for the number of children. That said, it remains to test the relative importance of the three identified channels of causation running from changes in mean real income through to changes in the level of fertility. The regression results set out in equation 2 allow the inference to be drawn that the quantity-cum-quality, and the opportunity-cost-

[17] This seems to be the general situation in most developing countries which have expanded their economies comparatively rapidly in the last few decades by learning how to exploit new technology, a process that was made possible by sharply increasing the level of investment in human beings. See Lucas (1993); Barro and Sala-i-Martin (1995).

for-mothers effects exist and combine to dominate, on average, the standard income effect. The alternative empirical evidence also cited (i.e. that set out in Subbarao and Raney 1995) suggests, however, that only the opportunity-cost effect is of importance, and this effect dominates the standard income effect. The theory developed in this section implies, however, that this is rather an unlikely situation.

The theory set out in this section does not allow for all relevant considerations which may influence fertility levels. Such a consideration might be changes in the tastes for children: as the income level for a couple rises they acquire a taste for fewer children (Birdsall 1988:509-510). Certainly the regression results presented in equation 2 are also not inconsistent with this line of argument since the term,-0.709 log (GNP_i/n_i), in equation 2 may simply be acting as a proxy for the shift in tastes just assumed to take place.

These various comments imply that the empirical results cited in the previous section do not provide an adequate or cogent test of the theory set out in this section. What is required is a far more direct test of this theory. Above all, what is required is information which directly records the reasons why couples alter their desires for a particular family size in situations of economic change. Fortunately such information does exist.

Some pertinent micro-survey data from central China

The information concerned is drawn from some evidence based upon a study of three villages in central China (Shaanxi Province) in the 1980s and early 1990s. In these villages Greenhalgh, Zhu and Li (1994) found that the crude birth rate[18] fell sharply from an average level of 30.1 for the period 1984-1987, to a level of around 13.0 for the period 1988 up to mid-1993. In addition, in the late 1980s two major changes influenced these communities: first, a more intensive application of family planning policy and, second, a sharp increase in the level of real income received by the average household in the villages concerned.[19]

Before going further it is useful to indicate, with a few pertinent comparisons, how remarkable were these changes in the crude birth rate in the villages concerned (World Bank 1995:Tables 1, 26). The first comparison is with the change in the weighted average crude birth rate for all low-income countries, excluding China and India. It declined from 45 in 1970 to 40 in 1993. In the case of all middle-income countries the decline was from 31 to 23 over the same 23-year period. Naturally these figures reflect much slower annual rates of decline compared to that experienced in the Chinese villages. Finally, and most remarkable of all, the crude birth rate in the Chinese villages in the early 1990s was the same as the weighted average crude birth rate for the *high-income* countries in the world in 1993:13 per thousand of the population.

What is particularly noteworthy about this latter comparison is that there are two factors which suggest that the crude birth rate should be higher in the Chinese villages than that for the high-income countries. First, the crude birth rate in a community is likely to be higher the larger is the proportion of the total population in the age group 15 to 45 years, other things remaining the same. While in 1993 this proportion almost certainly was larger in the Chinese villages than that for the high-income countries, yet both regions had the same crude birth rate. Second, the weighted average per capita income for the high-income countries in 1993 was US$23,090 (measured at current international

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[18] Number of births per 1,000 mid-year population.

[19] Greenhalgh et al. (1994:373) do not distinguish between real and nominal changes in per capita income, but it is presumed here that they are referring to real income changes.

prices):a figure many times greater than that for the three villages in central China in the same year.[20] Again this is a consideration which suggests that the Chinese villages should have had a crude birth rate in 1993 higher than 13.

Turning to consider in more detail the sharp increase in the level of real incomes received by the Chinese villagers, over the period 1988 up to mid-1993 per capita real income in two of the villages grew by a third, while in the third village it doubled. Respondents in the surveys indicated that this change had two consequences. One was that it raised the opportunity costs for mothers of bearing and raising children (see Greenhalgh et al. 1994:381). The other, and apparently the more important consequence, judging from the remarks by respondents cited in Greenhalgh et al. (1994), was that it raised, sharply, the level of demand for the quality, relative to demand for the number of children.

What induced this marked alteration in the preferences for couples was the form of the economic growth that took place during this period: the increased application of more scientific methods to the farming of vegetables and the diversification of economic activity into small-scale non-farm enterprises. Both of these changes, in turn, required more technical skills, rather than more physical human power, to be applied in relevant economic activities if the maximum benefits were to be derived from the new technology, and expanded economic opportunities, becoming available. This point was not lost on the villagers, some of whom, in interviews, expressed the opinion that a lack of formal education to, say, the junior middle-school level was an impediment (possibly a severe impediment) to attempts to exploit more fully the improving economic opportunities. This opinion was supported with action by parents becoming far more willing to expend resources on the education of their children.

> In 1987 it was not uncommon for families to pull their children out of junior middle and even primary school to perform unskilled farm labor. Today [in 1993], it seems that all couples want their children to finish junior middle school and to go on to high school and university if they can pass the entrance exams (Greenhalgh et al. 1994:379-380).

This sharp shift in the demand for the quality of children, associated with the increase in household real incomes, probably set in train the interacting responses of the form discussed in general terms in connection with equation 7 and Figure 2. The initial sharp increase in the demand for the quality of children resulted in a fall in demand for the quantity of children. The resulting increase in the shadow price ratio, π_n/π_q $(:=(p_c q/p_c n))$, quite possibly also induced further rounds of adjustments with additional resources being invested in the education of children and yet further declines in the demand for the quantity of children. Such an interactive process still seems to have been in progress at the time, mid-1993, of the last interviews reported by Greenhalgh et al. since the villagers concerned were still increasing the level of their investments in the quality of their children by spending more on the expansion of the local education system, and seriously contemplating sending their children away, if they had not done so already, for further education in the regional towns or cities.

Just such an interaction process was necessary to explain most of the previously-emphasized remarkably rapid decline in the level of the crude birth rate in the Chinese villages. The rest of this decline could then be explained by the increase in the opportunity cost of time for mothers in bearing and caring for additional children. But it would seem that this increased cost could only explain a comparatively small proportion of the fall in the level of the crude birth rate, although it is not possible

[20] The per capita income for China in 1993 was US$2,330. Added to this fact is that Shaanxi is one of the poorer provinces in China with a per capita income (in 1989) some two-thirds that of the national average (see World Bank 1993a:37; 1995:220).

to confirm this conjecture with firm empirical evidence (if any could be found).[21] As for the role of the family planning program in the villages concerned, its relative influence on reducing the level of the crude birth rate, while difficult to measure with any precision, probably was only marginal.

Some micro-survey data from India

It is also useful to compare the relevant experiences of these three villages in central China in the 1980s and early 1990s[22] with that for a sample of rural households surveyed in India in the 1960s and early 1970s (see Rosenzweig 1990:S52-S56). These households were split into those which were in a relatively favourable geographic position, and those which were not, to make use of the new region-specific agricultural ('Green Revolution') technology which became available in India in the early 1960s. To increase the benefits to be derived from this new technology it appears to have been discovered in the first group of households (called A) that the level of education needed to be raised. This response to the new technology is reflected in the fact that in A there was a relatively large proportionate decline in the percentage of male children not receiving primary school education, compared to that experienced by those households (called B) which had little scope to exploit the new technology: in A there was a 56.2 per cent decline while in B it was 30 per cent. In addition, the agricultural real wage rates paid in A rose by 24 per cent for males and 12.7 per cent for females, but increased only by 6.4 per cent for males and 3.4 per cent for females in B.

Given these facts, along with the previous discussions and the relevant evidence for the villages in central China, it is not surprising to find that the number of infants born to the average female in the age group 25 to 34 years fell by a larger proportionate amount in A (11.6%) than in B (2.6%). It is also noted by Rosenzweig (1990:S55) that this relative change in fertility levels took place without the application of a direct family planning program.[23]

Yet while this information is not inconsistent with the quantity-cum-quality, and the opportunity-cost-for-mothers, theories of fertility, it only provides indirect evidence in support of these theories. Relevant changes in behaviour can only be inferred from the facts provided. Nevertheless, what does allow greater weight to be placed on this evidence drawn from Indian data is that it is consistent, in broad qualitative terms, with that for the three villages in central China for the 1980s and early

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[21] Greenhalgh et al. (1994:80) were aware that the information they provided was consistent with the quality/quantity of children hypothesis. The discussion, however, is attempting to give particular emphasis to the information they provided.

[22] There is also some additional relevant information, to be found in Schultz and Zeng (1995), which is derived from cross-section data for parts of China in 1985. This data set does not allow, however, the theoretical issues raised here to be tested in the direct fashion that is possible with the aid of the information provided by Greenhalgh et al. Rather, only inferences can be drawn from the probit regression results presented by Schultz and Zeng. For example, after allowing for other factors, their results suggest that a rise in the education level for females reduces the level of fertility. It may be inferred from this result that as the opportunity cost to mothers of acquiring children rises so the level of fertility declines. In addition, and again after allowing for other considerations, Schultz and Zeng find that the fertility rate is lower in those households whose members are employed in economic activities which require the use of comparatively skilled labour. One tentative inference that may be drawn from this empirical result is that the couples concerned are more aware of the need to expend resources on improving the quality of children born into their families rather than acquiring more children.

[23] Rosenzweig (1990:S55-S56) recognized that he had some difficulty in explaining the size of the proportionate fall in the level of fertility for the households in A. The source of this problem seems to be that the neoclassical economic model of the household behaviour devised by Rosenzweig did not make use of a non-linear budget constraint in the way discussed above in the section on 'non-linear budget restraints'. As a consequence the general theory he developed did not possess a set of terms, as is the case in equation 7, which allowed for the possible interaction between quality and quantity effects.

1990s:evidence which, as pointed out earlier, allows a far more direct test of the main thesis of interest here.

The influence of the revised family planning policy in the villages in Central China

Returning to consider the Chinese case alone, the various changes in the shadow price ratio, π_n/π_q, must have interacted with the family planning policy since, according to Greenhalgh et al. (1994:387), households became more receptive to the information provided by this program. What is clear, however, is that the influence of the expanded family planning policy from 1988 on should not be over-emphasized in any explanation of the fall in the crude birth rate in the villages concerned.[24]

To explain this assertion, and in addition to the theoretical points made earlier in footnote 16 , it is pointed out that family-planning services played essentially a passive role during the various changes experienced after 1988. As evidence of this, first it is noted that the provincial government stated that it would pay, to both parents in a two-daughter household, a pension of 60 yuan a month on reaching the age of sixty if the mother agreed to undergo sterilization. Clearly the economic value of this pension, when appropriately discounted, is likely to be small (relative to the other sources of income for the couple) since it is to be paid so far into the future. In addition, before the payment of the pension many relevant factors could change which might reduce its real value.[25] Therefore, this element of the family planning policy does not seem to provide an acceptable substitute for the potential old-age support to be derived from having sons in a family. Thus any influence that the family planning program may have had on the level of fertility in these villages seems to have been due to a growing demand for the facilities provided by this program rather than any increase in the supply of these facilities.[26]

Real income changes and variations in the TFR in Sub-Saharan African countries

Now that the quality-cum-quantity of children hypothesis, in particular, and the opportunity-cost-to-mothers assumption have been more firmly established as being consistent with relevant household behaviour, a further implication of this theory can be more confidently deduced from equation 7. If this implication is confirmed by some relevant facts then this is further reason not to reject the quality-cum-quantity of children hypothesis.

To derive this implication, consider a poor country in which the broad application of improved technology in the economy has hardly begun. As the level of mean real income for this community

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[24] As for the situation in, or just before, 1988, the evidence for China as a whole is that the family planning policy was having little influence on the level of the TFR. After assessing the data for Hebei province, drawn from the Two-per-Thousand National Fertility Survey conducted in 1988, Li (1995) points out that the one-child policy was having little influence on women in rural areas who wanted to have more than one child. In these areas, of those having more than one child, only ten per cent were provided with a permit to have additional children. Schultz and Zeng (1995:344) also recognize that the family planning policy for the mid-1980s in China can explain only a small proportion of the decline in the TFR there between 1979 and the mid-1980s.

[25] It is implied by Greenhalgh et al. (1994) that the pension is designated in nominal terms, not real terms. Since the rate of price inflation in China in the late 1980s and early 1990s was 10-30 per cent, the real value of the pension would soon erode to very little if this rate of inflation persisted into the future.

[26] This also seems to have been the situation in Indonesia in the mid-1980s. Listing data for this country, Gertler and Molyneaux (1994) attempted to disentangle the influences on the TFR of the demand for family-planning services and the supply of these services. The empirical results suggest that changes in the level of demand for contraception had by far the greater influence on reducing the TFR in that country. The influence of the supply of family planning on reducing the TFR was difficult to assess, however, since, as Gertler and Molyneaux imply, the supply of this community service was not varied appreciably during the period under consideration.

increases it seems reasonable to assume, therefore, that the quality-cum-quantity of children effect is likely to be insignificant. In these circumstances, and even if the opportunity-cost-for-mothers effect is present, it is likely that the pure income effect for children will dominate in these early stages of economic development, other things remaining the same. Thus as the level of mean real income increases (resp. decreases) the total fertility rate will tend to rise (resp. fall), given that the number of children is a normal good in these poor communities. This may be called the Malthusian case. As this economy develops further, however, through the process of the introduction of improved technologies, eventually the quality-cum-quantity of children, and the opportunity-cost-for-mothers, effects come to dominate and the fertility rate begins to fall as the level of mean real income increases in this now less poor community. Thus one way of testing the model of fertility behaviour represented in equation 7 is to determine if the Malthusian case applies in poorer countries.

There are some pieces of recent empirical evidence that bear on this matter. The first piece of evidence is drawn from a regression equation estimated by Barro and Sala-i-Martin (1995) making use of cross-country data. Based on the results they obtained, Barro and Sala-i-Martin (1995:453) estimated that as the level of mean real income rises over the range from zero to $767 (in 1985 US dollars) so the level of the TFR also rises. Above this mean income level the level of the TFR falls as the level of mean real income rises.[27] While this result is not inconsistent with the theory set out in the previous paragraph, again other factors may be at work which explain this link between changes in the TFR and changes in the level of mean income. For example, the change in the level of mean income may simply reflect changes in the level of knowledge concerning the controlling of fertility. Indeed, as the regression results presented in equation 2 indicate, once family planning effort is allowed for (amongst other things), then the Malthusian case does not apply and there is an inverse relationship, over all income levels, between the level of the total fertility rate and the level of mean income.

This observation indicates that additional methods need to be found to determine if the Malthusian case does apply in some, if not all, poor countries. The alternative method used here is based on considering relevant data for a range of sub-Saharan African countries whose rural populations, during the 1980s, tended to experience either a decline, or only comparatively small gains, in mean real incomes. These countries are some of the poorest in the world (see Table 1). In the World Bank tables of development indicators there are 132 countries listed of which 31 are in sub-Saharan Africa. If the world poverty line is drawn at US$2000 per capita, then 26 of these African countries could be considered to be poor in 1992 (World Bank 1994). These facts suggest that these African countries did

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[27] The truncated form of the regression equation that Barro and Sala-i-Martin (1995:453) estimated was the following:

$TFR_i = a_{oi} + 0.93 \log (GNP_i/n_i) - 0.0.70 [\log (GNP_i/n_i)]^2 +$ various measures of education, where the coefficient estimates shown in this equation were different from zero at the standard levels of statistical significance. An attempt to estimate a version of this equation, based on equation 2, had unsatisfactory results. The estimate for one of the regression equations considered was the following:

$$TFR_i = \underset{(8.704)}{9.401} \underset{(-1.819)}{-0.814} \log (GNP_i/n_i) + \underset{(0.042)}{0.036} [\log (GNP_i/n_i)]^2$$

$$+ \underset{(3.252)}{0.984} D_{i1} + \underset{(3.252)}{0.753} D_{i2} \underset{(-2.714)}{-0.689} \log HDI_i \underset{(-6.693)}{-1.094} \log FPE_i.$$

Besides the coefficient estimate for $\log (GNP_i/n_i)$ squared not being significantly different from zero, this coefficient also does not possess the required sign.

not experience any marked changes in the application of improved technology during the 1980s. Thus there was probably little change in the average level of demand for skilled labour in these countries over this period.

Within this context the initial discussion in this section suggests the following thesis needs to be tested: during the 1980s and early 1990s the direction of change in the TFR in sub-Saharan countries tended to bear a positive relationship with the direction of change in the level of real income per capita for these countries.

Some relevant data required to test this thesis are set out in Table 1. Since in the 1980s most people in the countries listed there lived in rural areas,[28] use is only made of the average rate of growth of agricultural production per capita over the period 1980-91 in the countries concerned.[29] This agricultural output information is compared with that for the levels of the TFRs for the relevant countries for the years 1987 and 1991. In addition, in Table 1 countries are grouped into those for which there is a positive, or no, relationship between the rate of growth in agricultural output per capita and the change in the level of TFR; and those for which there is a negative relationship.

A more sophisticated manipulation of these data, other than this grouping of them, does not seem appropriate, remembering that there is a complete absence of additional relevant data for all the countries listed. In view of this dearth of information, heavily qualified judgements need to be applied when interpreting the information set out in Table 1.

Others have noted that from the early 1980s to the early 1990s a number of sub-Saharan African countries experienced a decline in the TFR at a time when the rural populations in these countries also suffered from declining economic fortunes (see Caldwell, Orubuloye and Caldwell 1991:237; Lesthaeghe and Jolly 1994:238; Dow et al. 1994:357). This observation is also confirmed by the data set out in the upper part of Table 1. Those countries that did experience a rise in rural per capita incomes also, with one exception (Nigeria), experienced a rise in their TFRs. Thus 70 per cent of the sub-Saharan countries listed in Table 1 experienced, in the 1980s and early 1990s, changes in TFRs not inconsistent with the Malthusian thesis.

In Botswana in the late 1980s and into the early 1990s a severe drought came to an end. The resulting rise in rural household incomes in that country was accompanied by a rise in the TFR in the rural areas (see Diamond and Rutenberg 1995). This is just what the theory of demographic change being tested here would predict in a rural community where there seemed to be little reason for couples to increase the level of investment in the quality of their children.

As for those countries which experienced demographic change inconsistent with the Malthusian model, there appear to have been other factors, besides just normal income effects. The growth of the relative size of the urban population probably was one such factor. In the instance of Nigeria the proportion of the total population living in urban areas grew from nine per cent in 1970 to 20 per cent in 1991, while for Tanzania this proportion grew from seven per cent to 34 per cent over the same period (World Bank 1993b:Table 31). It is also known that the TFR is lower in urban than in rural areas in sub-Saharan African countries (Locoh 1994:119). This growing urbanization may represent, however, a whole range of socio-economic changes which impinge on household behaviour. One of these socio-economic changes may have been a growing level of investment in the quality of children.

This idea also seems to be supported by some of the demographic changes experienced in Botswana in the 1980s and 1990s. As noted earlier, the TFR for the rural community in that country

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[28] In some countries about 40 per cent, but usually a much smaller proportion, of the total population lived in urban areas. See World Bank (1993b:Table31).

[29] These data are not particularly reliable for developing countries where a sizable proportion of agricultural output does not enter the monetized market system. See World Bank (1993b:308). Data for the rate of growth of Gross National Product per capita are not used since this information will, for some countries, strongly reflect the influence of mining, an economic activity which may well only benefit a comparatively small section of the population.

rose in the early 1990s. The TFR continued to decline, however, in the urban areas of Botswana at a time when the average urban household real income was increasing (Diamond and Rutenberg 1995).

This continued fall in the TFR in urban areas was presumably a consequence of the greater level of demand for human technical skills, as well as the greater access to basic health care, schooling and advice on family planning in the urban areas of Botswana compared to that found in the rural areas.

Despite these conflicting results, the broad conclusion that seems reasonable from the information set out in Table 1 is that the Malthusian case of fertility change influenced demographic change for a sizable proportion of sub-Saharan countries in the late 1980s and early 1990s. This is what the theory based on equation 7 would suggest given that these countries are absolutely poor, or near-poor, which, in turn, implies that the communities in them expend relatively small amounts on the quality of children. As for those sub-Saharan countries, identified in Table 1, for which the Malthusian case does not seem to apply, the demographic change experienced by them in the 1980s and early 1990s still needs to be explained.

From these observations it does not seem that, around 1990, the fertility transition had begun in any sustainable way in the average sub-Saharan country. For this fertility transition to be sustainable it seems, particularly with the insights provided by the recent demographic experiences in a part of central China, that more effort needs to be devoted to altering the mechanisms through which increases in household real incomes in sub-Saharan countries are generated. Such mechanisms would need to create an increasing level of demand for skilled human power in these countries. This change, in turn, would create the incentive for couples to invest more in the quality of their children at the expense of acquiring a greater quantity of children. A subsidiary consequence of this change in incentives is that probably they would induce a greater demand for family planning services.

Table 1
Pertinent economic and demographic data for a range of sub-Saharan African countries

Country	Rate of growth of agricultural output per capita	Total Fertility Rate[b]		GNP per capita current intl prices
	1980-1991[a]	1987	1991	1992[c]
Countries for which data not inconsistent with the thesis				
Botswana	-0.5	6.7	4.9	5,190
Burkina Faso	0.6	6.5	7.2	730
Cameroon	-1.7	5.9	5.8	2,300
Central African Republic	-0.3	5.9	5.6	1,040
Congo	-0.1	6.8	5.9	2,450
Ghana	-2.01	6.5	6.3	1,890
Kenya	-0.6	8.0	6.7	1,360
Rwanda	-4.5	8.5	8.1	770
Senegal	-0.3	6.7	6.5	1,,750
Sierra Leone	0.3	6.2	6.5	770
Tanzania	1.4	7.1	7.1	630
Togo	1.9	6.6	7.2	1,100
Zimbabwe	-1.2	6.5	5.6	1,970

Zambia	-0.3	7.8	7.2	-
Countries for which data inconsistent with the thesis				
Côte d'Ivoire	-5.0	6.7	7.4	1,640
Madagascar	0.6	6.1	6.6	720
Malawi	-1.1	7.0	7.7	730
Mali	-0.2	6.7	7.1	600
Mozambique	-1.0	6.1	6.3	570
Nigeria	0.5	6.6	6.0	1,440

Sources: a: World Bank (1993b:Tables 2, 26); b: Locoh (1994:130); c: World Bank (1994:Table 30).

Conclusions

Part of the previous discussion indicated that, because of the dearth of suitable information, it is rather difficult to provide a satisfactory test for the quality-cum-quantity of children hypothesis. In the attempt to provide reasonably convincing tests a particular strategy was adopted. To begin with, a flexible version of the relevant theory was constructed to indicate the general set of circumstances where the quality-cum-quantity of children hypothesis is likely to apply; and when it does not and the Malthusian case is likely to obtain. This theory indicated the information required to provide a direct, and strong, test of the hypothesis. Information near to the required form is available: information from central China in the 1980s and early 1990s. Indirect, but much weaker, tests of this theory were provided by relevant information drawn from India in the 1960s, and sub-Saharan Africa in the 1980s and early 1990s. Overall these various tests were not inconsistent with the theory of when the quality-cum-quantity of children hypothesis is likely to be satisfied, and when it is not, and the Malthusian case applies.

One of the implications of this testing of this theory is that the type of economic growth taking place in a community is likely to influence how much the increase in mean income will reduce the total fertility rate in this community. Another implication of this testing is that it seems difficult to predict, reasonably accurately, TFRs over the medium to longer term for a developing country in which dynamic economic change is taking place, or is likely to take place. This is so because in these circumstances various relevant variables will probably interact in complex ways to influence the fertility rate, and it seems difficult to predict the extent of the influence of these interacting effects. Yet when these interacting effects are prevalent, they may have a marked, if not dramatic, influence in reducing fertility rates, as was the case, apparently, in an area of central China in the 1980s and early 1990s. When these interacting effects are more muted then changes in the level of fertility rate may take a rather different course.

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