ECONOMIC FACTORS AFFECTING POPULATION GROWTH: A PRELIMINARY SURVEY OF ECONOMIC ANALYSES OF FERTILITY

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T. Paul Schultz

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Center for Economic Research
Department of Economics
University of Minnesota
Minneapolis, Minnesota 55455

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INTRODUCTION

There is not now a satisfactory theory of all factors affecting birth and death rates and hence there is no complete theory of what affects population growth. But in the last decade considerable progress has been made in explaining differences in fertility within an economic framework. Few would argue either that economic factors are preeminent among the determinants of individual reproductive behavior or that economic constraints on households exert no appreciable effect on reproductive goals and behavior.

The more pragmatic question I propose to discuss is the power and limitations of the state of the arts in economic analyses of fertility. First, I survey efforts to view fertility

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as a response to time and resource constraints, and review empirical evidence suggesting the magnitude and importance of several of these apparently causal relationships.[1] To indicate the focus of current research, I then outline several unresolved problems in the field. In conclusion, I speculate on how economic inquiry along these lines might help in the future choice, formulation, and evaluation of public policy.

I. A FRAMEWORK FOR ANALYSIS AND ITS EVOLUTION

The classical economic demographic model of Malthus did not emphasize the role of relative prices, but did assume for the most part that parent demand for children was a "normal" increasing function of real wages. Malthus conjectured that fluctuations in death rates (positive checks), triggered by macro-economic or political forces, sustained the long-run balance at some subsistence wage between man's resources and his numbers. But both the level and volatility of death rates have secularly declined, and evidence has accumulated that income and fertility are frequently inversely associated over time and across populations. Powerless to explain these phenomena, many social scientists have rejected the contemporary relevance of Malthusian theory and have looked elsewhere for a theory of fertility.

Harvey Leibenstein (1954) and Gary S. Becker (1960) were the first to examine the usefulness of micro-economic analysis for understanding reproductive behavior. But research on

fertility progressed slowly until it became evident that there were observable sources of variation in the relative prices of children associated with the value of time parents allocated to the care and enjoyment of their children.[2] Opportunity cost was interpreted in this context by Jacob Mincer (1963) to encompass this shadow price of time that consumers used to satisfy their demands. Since the shadow price of time was generally linked at the margin to the wage rate and was therefore positively correlated with household full income[3], direct estimates of the effect of income on the demand for time-intensive commodities were biased downward by the omission of an appropriate "price-of-time" variable.

Mincer illustrated his point with reference to fertility by regressing numbers of children on proxies for husband's and wife's full-time earnings. The regression coefficient on the husband's earnings was interpreted as the income effect and the difference between the coefficients on the wife's and husband's earnings was interpreted as an estimate of the compensated (holding income constant) price effect associated with the wife's opportunity cost of time in the bearing and rearing of children. Four sets of U.S. cross-sectional data were considered by Mincer and the absolute value of the negative estimates of the price elasticity generally exceeded the positive income elasticity. If the secular increase in the market value of women's time was equal to, or greater than, that for men, Mincer's estimates could help to account for the secular decline in fertility. His approach also implied that the effect of an uncompensated

change in income on the demand for children would depend on the source of income, and hence the price effects embodied in that source. The lack of an invarient positive relationship between family income and fertility could no longer be interpreted, even loosely, as a challenge to the relevance of economic scarcity to the fertility decision.

More formally, the nuclear family may be assumed to allocate the time of its members among three activities--market work, children, and a composite production-consumption commodity. (See Becker (1965) for a generalized treatment of the allocation of time.) For simplicity each spouse is assumed to spend some time in each of these three activities.[4/] If children are not an inferior good, as seems plausible in this restricted context, an exogenous increase in the household's stock of nonhuman wealth shifts the demand schedule for children unambiguously to the right.

Exogenous increases in the household's stock of human wealth, as reflected by an increase in a parent's permanent (lifetime average) wage rate, implies both a positive wealth effect and an offsetting increase in the cost of parents' time required in child-rearing. Yoram Ben-Porath (1973) has shown for linear homogenous separable household production functions, the elasticity of demand for children with respect to either spouse's wage rate can be decomposed into the usual weighted combination of compensated price elasticity and income elasticity of demand for children; the price elasticity is weighted by the value share of the respective

spouse's time in the total cost of children minus the value share of the spouse's time in the cost of producing the composite commodity; the income elasticity is weighted by the value share of the spouse's market earnings in household's full income.[5] Stronger assumptions are required to prescribe the sign of the wage elasticities, but plausible magnitudes for these weights suggest that the elasticity of fertility with respect to the wife's wage will be algebraically smaller than that with respect to the husband's wage, given the time intensity of children and the predominant role of mothers in child-rearing.

Cross-sectional studies of countries at all levels of economic development have confirmed the qualitative predictions of this rudimentary demand theory of fertility. In part because of the difficulties of measuring a permanent wage rate, particularly for women not currently in the paid labor force, education has often been assumed to be a satisfactory proxy for wage rates. When fertility is then regressed on the educational level of men and women, the women's education coefficient tends to be negative, as anticipated, and several times its standard error, while the men's education coefficient is smaller in absolute magnitude and generally less significant statistically.[6] The elasticity of fertility with respect to women's years of education evaluated at regression means ranges from about -.1 to -.5, whereas for men the elasticity estimates are smaller and of either sign. When regression analysis deals with average earnings for men and women within regional population aggregates, or earnings of individual couples where the husband and wife are currently

working, the t values for the women's earnings coefficient tend to be higher than that for the alternative women's education coefficient, and the regression coefficient is more often positive for men's earnings than it is for men's education.[7/]

The predicted positive relation between exogenous differences in nonhuman wealth and fertility is less often tested, because of the scarcity of information on personal nonhuman wealth and the endogenous nature of related savings behavior. Although wage and wealth effects on fertility may go far in explaining cross-sectional differences in fertility in high-income countries, the regime of mortality cannot be neglected in low-income countries. How can this "demographic" variable, whose recent change is the proximate cause for the population explosion in much of the world, be incorporated into the economic demand model of fertility?

II. CHILD MORTALITY

If we assume that parents are motivated to bear children to accrue benefits from their mature surviving offspring, the effects of child mortality on desired fertility can be divided into two partially offsetting effects on (1) the demand for survivors and (2) the derived demand for births. Mortality affects the number of survivors demanded by increasing the expected cost per survivor; it affects the derived demand for births by increasing the number of births required to obtain a survivor. The derived demand for births will decline as the incidence of child mortality declines only if the product of the percentage change in expected cost per survivor and the elasticity of demand for survivors is less than unity (in absolute

value). Long run demographic stability may therefore generally require a less than unitary elastic (inelastic) demand for surviving children (Donald J. O'Hara, 1972; Ben-Porath and Finis Welch, 1972).[8/]

Undoubtedly parenthood is one of the most risky undertakings that economists have proposed to study, and the above formulation implicitly assumes that parents are risk neutral. The potential importance of uncertainty for understanding shifts in fertility has been stressed in the context of low-income countries where child mortality has declined sharply (T. Paul Schultz, 1969), but theoretical consideration of this relationship has only recently begun (O'Hara, 1972; Ben-Porath and Welch, 1972), and I know of no empirical evidence as yet that separates the effect on fertility of uncertainty from that of child mortality.

However, individual and aggregate evidence from a variety of low-income countries indicates that the partial relationship between fertility and child mortality is positive and statistically highly significant in such varied environments as Bangladesh, Puerto Rico, Taiwan, Chile, and the Philippines. Where fertility is measured as a birth rate or probability of birth, the multiple correlation is maximized by lagging the incidence of child mortality two to four years. This is, of course, roughly the average time required for a mother to bear another child. There are persuasive reasons to anticipate that older mothers with nearly completed families, will weigh heavily the survival or death of earlier children in their decision whether to have

an additional (marginal) child. Consistent with this explanation of reproductive behavior, estimates of the responsiveness of births to child deaths are larger in magnitude and more significant statistically for women over 30 years of age (Julie DaVanzo, 1972; Schultz and DaVanzo, 1970; Schultz, 1971, 1972). Among these older women, the response of birth rates is also greater to male child deaths than to female child deaths (Schultz and DaVanzo, 1970; Schultz, 1972), presumably reflecting preferences for family sex composition. Since the death of a nursing child is assumed to stimulate also a biological feedback mechanism increasing a mother's subsequent fecundity (supply), the robust differences in empirical estimates of this positive lagged relationship by age of mother and sex of the dead child confirm the independent importance of the behavioral factors determining the demand for (and supply of) children.

I think we may conclude that birth rates of older mothers respond promptly to changes in child mortality, but these short-run adjustments are apparently not always sufficient in magnitude to prevent growth in the size of surviving families as the incidence of child mortality has decreased. Demand for surviving children appears to be price inelastic, but far from perfectly inelastic. Cohort data on completed fertility will be needed to determine whether long-run adjustments of fertility to the changing regime of mortality are in fact also taking place. Future rates of population growth in much of the world may hinge on the magnitude and speed at which these adjustments occur.

The consistent effects on fertility of the shadow price of husband's and wife's time, and child mortality, account for a statistically significant share of cross-sectional variation in aggregate and individual reproductive behavior. Encouraging though these empirical results may seem, there are serious ambiguities and limitations to this conceptual approach and its current empirical application. In the remaining space allotted to me, I shall comment on a few of the unresolved problems that I find most challenging.

III. THE RESOURCE INTENSITY OF CHILD-REARING

In arriving at the number of children they want, most parents consider a richer range of activities than reproduction and subsistence support of their children. Reproductive motivations may be better understood by studying the closely related choice parents make regarding the time, energy, and resources they want to invest in each of their offspring (Becker, 1960). Widely observed empirical regularities suggest that parents have a tendency to tradeoff resource intensity per child for numbers of children (e.g. Schultz, 1969, 1970, 1971; DaVanzo, 1972).[9/] Understanding the determinants of this tradeoff promises to account for much of the systematic variability in fertility in both high- and low-income countries.

A third consumption commodity--the resource intensity of the child-rearing process or child "quality"--can be added to the two-good model of household choice, but resulting expressions for the derived demand for child quality and quantity are not particularly illuminating unless additional restrictions are

imposed (Dennis N. DeTray, 1972).[10] With the objective of obtaining an analytical reduced-form expression for the derived demand for numbers of children, Robert J. Willis (1971) proposed a specific set of restrictions to the general three-good model. He assumed that the husband does not contribute to household production, holding constant his full-time market participation, and with standard assumptions regarding production functions and factor intensities, he obtained two novel predictions: 1) An increase in the husband's lifetime wage increases the demand for children by a greater amount if the wife engages in market work; 2) An increase in the wife's education (i.e. market-specific human capital) has a deterrent effect on demand for children only if she is engaged in market work. In a later extension of his model, Willis (1973) treats the wife's labor force participation decision as endogenous, but not without a loss of refutable predictions.

The choice of appropriate constraints to the three-good model will, in my opinion, rely on further research that determines how numbers of children, child quality and other consumption activities are related in household production; how quantity and quality are assessed by parents; and how they are usefully approximated in empirical study. Work has already touched on these difficult issues (Arleen S. Leibowitz, 1972; James P. Smith, 1972; Reuben Gronau, 1973) and analysis of time-budget survey information is now underway that promises to provide additional insights.

IV. PROBLEMS OF EMPIRICAL INFERENCE AND MODEL SPECIFICATION

Difficulties of inferring the direction, magnitude and timing of causality have become clearer as this framework of constrained choice has been applied to new data on reproductive behavior, suggesting also the need to reformulate elements of the underlying theoretical approach. Observations on exogenous differences in wage rates and nonearned income, from which price and income effects might be estimated without simultaneous equations bias, are hard to come by. Virtually all of the decisions parents make over the lifetime affect the subsequent structure of incentives bearing on fertility, and most individuals recognize that their current choices modify future options. Therefore, many attributes of the household and its members that reflect past or current choices cannot be treated as exogenous to the fertility decision.[11/] Proxies that appear initially useful as measures of the opportunity cost of children or of given resource constraints must ultimately be treated as endogenous variables in a broader simultaneous system of behavioral equations.

For example, the educational attainment of the wife, which I regarded above as an exogenous determinant of the opportunity cost of her time in childbearing, is <u>not</u> an exogenous variable with respect to her husband's wage rate, education, or tastes for children. The selection of mates is undoubtedly responsible for the high simple correlation between educational attainments of spouses. Mate selection and, of course, the life cycle allocation of both spouses' time between market and nonmarket

activities are decisions that are intimately related to similar price and income variables as well as underlying tastes. The extension of fertility models to encompass additional areas of jointly and simultaneously determined household choices has confirmed the importance of interactions among at least these three forms of behavior: reproduction, the incidence of marriage (legal and consensual, where distinguished) and the sex division of labor market participation within the family (DaVanzo, 1972; Alan Frieden, 1972; A.J. Harman, 1970; K.M. Maurer, et.al. 1972; Marc Nerlove and Schultz, 1970; Schultz, 1970). Beyond this core, models of household decision-making might be reasonably extended to incorporate additional allocative choices that are also probably endogenous to the determination of fertility, such as savings and nonhuman capital formation, migration and, as emphasized in the preceding section, the resource intensity of the child-rearing process.

But these simultaneous equations models are still formulated in static terms and tested, most often, against cross-sectional data from one point in time. Though I would not deny that this abstraction has proven a powerful generalizing device, little attention has as yet been given to the question of what economic theory and statistical techniques can say about dynamic models of behavior. Reproduction occurs sequentially, and the constraints on childbearing affect many other areas of economic and demographic decision-making in the household and are influenced themselves by past reproductive behavior.

In cross-sectional studies, explanatory variables are at best discretely lagged a few years, as noted with regard to child death rates, to represent the time required for reproduction to respond and for birth control information to take effect (Schultz, 1971). But the stochastic biological nature of the reproductive process and the numerous neglected features of the individual that could affect reaction times suggest that a distributed lag would be more appropriate to the study of changes in fertility. Identification and estimation of these lag structures are, nonetheless, difficult because of the limited availability of time-series information and the strong positive serial correlation (over time) of relevant characteristics of regional populations or individuals such as wages, nonhuman wealth, industrial structure, and schooling.

When the identical demand model of fertility is estimated from cross-sectional data and re-estimated from a combined time series of cross sections, assuming a two-component Nerlovian model of the disturbances, anticipated shifts in parameter estimates occur. Cross-sectional estimates of the impact on reproduction of slowly changing environmental constraints, such as child mortality[12/] and wage rates, tend to be biased upward or distorted. Conversely, factors that are less highly serially correlated over time, such as recent family planning activities, tend to be attributed too small an impact when estimated from a cross section (Schultz, 1972). Thus, estimates of the parameters to such a dynamic behavioral process may be

seriously biased, if they rely only on the information contained in a single cross section.

The character of family size, moreover, suggests that linear demand models are too restrictive for the study of fertility. Both theoretical arguments (Willis, 1973) and empirical evidence (Ben-Porath, 1970; Masanori Hashimoto, 1972; Julian L. Simon, 1972) have been presented for nonlinearity between explanatory variables and fertility. But at a more fundamental level, there is the question of how to specify the utility function with regard to numbers of children, and how the production function for children changes with scale. Linear demand models presuppose that the desirability of all increments to family size are affected identically by shifts in economic constraints. It seems reasonable to me, to now study separately the sequential binary choices made in the family formation process; this approach would in fact determine whether price and income effects differ by birth order.

V. PUBLIC POLICY

The search for policy options to cope with rapid population growth often mirrors a natural but nonetheless one-sided view of available choices. It seems far simpler to disseminate a better birth control technology, which is already available, than to modify parent reproductive goals by indigenous processes of social change about which little is known. For example, expenditures on family planning might lower the supply price

of modern birth control technology and hence reduce the cost (pecuniary and subjective) of restricting fertility. Alternatively, expenditures on, say, public health might reduce child death rates contributing to a downward shift in parent demand for numbers of births. Both sets of policy options--the "supply" and "demand" sides--need further quantitative study if decision-makers are to be able to select an equitable and efficient mix of birth control and development policies for each setting.

If, as is often asserted, familial behavior, involving marriage, reproduction, and women's role in the labor force, is particularly resistant to environmental changes associated with alternative development strategies, then to align development policies to foster the adoption of smaller family size goals may be ineffectual, and public policy would wisely emphasize improvements in birth control technology and the dissemination of these improved techniques to all strata of society. Alternatively, popular acceptance of better birth control methods may not independently accomplish substantial reductions in the birth rate, if demand for children is inelastic and family size goals are insensitive to the available mode of birth control.

Suppose the level and personal distribution of economic goods and services in a society affect fertility, and the relationship between economic and demographic variables and fertility can be specified and estimated with increasing precision. It would

be surprising indeed if a better mix of development policies were not then found that would accomplish nearly all that is currently sought, but held the added promise of affecting the rate of population growth. The potential of the economic demand theory of fertility outlined in this paper is that it provides society, in principle, with a decentralized means to bring into better balance social and private interests in having children.[13/] This might be accomplished without sacrificing the important function individuals perform best--evaluating, ordering, and satisfying their own wants.

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FOOTNOTES

1/ I have excluded from this survey cross country comparisons of fertility and its determinants because of my uneasiness with the data. Not only do the usual problems of relative prices and inconvertible exchange rates make international comparisons of income levels treacherous, but also most of the additional data required to test the propositions discussed in this paper are not meaningfully culled from standard international compendiums. For example, no experienced demographer would accept registered birth and death rates as satisfactory evidence of fertility and mortality levels in most low income countries, yet official or registered vital rates are the basis for many international cross-sectional regression analyses. Education statistics have their own problems; female labor force participation rates reflect local conventions; wage rates for men and women are rarely compiled and when they are available, they tend to represent only a small segment of the labor force, such as that in modern manufacturing. All of the criticisms raised later with reference to cross-sectional studies of regional populations within one country, apply with greater force to cross-sectional studies which span the even greater diversity of national institutions, statistical conventions and cultures.

2/ Some economists are skeptical of this approach, as for example Chenery (1966) in his survey article on development policy: "While the concept of opportunity cost can be extended to include a number of nonmarket phenomena, such as labor training and overhead facilities, it can hardly be stretched to

Footnotes continued...

cover differences in fertility rates or political attitudes. So far as I can see, in the present state of knowledge of social phenomena, considerations such as these may be used to modify the results of economic analysis but cannot be directly incorporated into it." (p. 152).

3/ Full income is defined as the sum of household members' disposable time weighted by their respective market wage rates, plus returns on household nonhuman wealth.

4/ The occurrence of "corner solutions" in the household's allocation of members' time among market and nonmarket activities both simplifies and complicates the analysis in an interesting manner. See for example Willis (1971, 1973); Gronau (1971, 1973).

5/ The elasticity of demand for children with respect to the i^{th} spouse's wage rate can be expressed as:

$$\eta_{CW_i} = \eta^*_{C\pi_C}(S_{iC} - S_{iG}) + \frac{N_i W_i}{I}\eta_{CI} ,$$

where η_{xy} is the elasticity of demand for x with respect to y; η^* is the compensated price elasticity, holding full income, I, constant; C is numbers of children and G is the other composite good; W_i is the (market) wage of the i^{th} spouse, and N_i their hours of market work; π_j is the full price of the j^{th} commodity; and S_{ij} is the share of the full price of j that is added by the i^{th} spouse's direct time input.

It may generally be assumed that $N_i W_i$ is greater for the husband than wife, since the male's market wage and hours working

Footnotes continued...

in the market labor force tend to both be greater than the female's. Thus, the positive income elasticity will be weighted more heavily for the male wage elasticity than for the female, although few would argue that the demand for children is particularly income elastic. Also, the difference between the female time-intensity of children and that of other non-market goods probably equals or exceeds the difference between the male time-intensity of children and that of other nonmarket goods, although this may depend upon the degree of market specialization and the structure of the family. In this case, the relative magnitude of the income effect prevails over the price effect and the elasticity of demand for children with respect to the man's wage will be at least algebraically larger than the elasticity with respect to the woman's wage.

6/ See for example where both male and female education is considered: Ben-Porath (1970, 1973) on Israel; DeTray (1972) U.S. counties; Gardner (1972, 1973) rural U.S.; Hashimoto (1972) Japan; Maurer, et.al. (1972) Thailand; Michael (1971) Suburban U.S.; and Schultz (1972) Taiwan.

7/ See for example where income, earnings or wage rates of males and females considered: Cain and Weininger (1971) U.S. SMSAs; DaVanzo (1972) Chile; DeTray (1972) U.S. counties; Gardner (1973) rural N.C.; and Hashimoto (1972) Japan. Male income and female education are analyzed for the U.S. by Sanderson and Willis (1972); Simon (1972); and Willis (1971, 1973). Because

Footnotes continued...

simultaneous equations bias is probably severe when both education and wages of spouses are included as explanatory variables in ordinary regressions on fertility, the empirical results of such studies are not reported here.

8/ The elasticity of demand for births, B, with respect to the probability of a child's survival to maturity, P, can be expressed as follows:

$$\eta_{BP} = \eta_{SC}\eta_{CP} - 1$$

where S is the number of births that survive from which parents are assumed to derive utility under risk neutral assumptions, and C is the expected cost of a surviving child which is assumed to depend inversely on P, and be independent of family size. Since it is known that η_{SC} and η_{CP} are both less than zero, if their product is less than unity, the elasticity of demand for births with respect to the probability of survival will be negative. Ben-Porath and Welch (1972) illustratively assume that $\eta_{CP} = -1$, whereas O'Hara indicates why it might exceed in absolute value unity. The positive relationship observed between child mortality and fertility is therefore suggestive of an inelastic demand for surviving children, i.e., $|\eta_{SC}| < 1$.

9/ Child schooling rates are often more highly (negatively) correlated with fertility than are educational attainments of mothers. Conversely, a positive partial correlation is generally observed between fertility and the rate at which young children enter the labor force in low income countries. See for example, Schultz (1969, 1970, 1971); Nerlove and Schultz (1970); DaVanzo, (1972); Maurer, et.al. (1972). One might conjecture that parents in some poor populations borrow, on balance, from

Footnotes continued...

their children over their lifetime rather than invest in them (Schultz, 1971). Increased attention to the implicitly producer good (capital) attributes of children may yield additional insights into the determinants of fertility in low-income countries.

10/ Without additional restrictions, the only qualitative prediction is the positive sign of the effect of nonhuman wealth on the demand for both quality and quantity. DeTray (1972) estimated a special form of this model with U.S. county aggregate data and found that the wealth elasticity of demand for quality per child was not significantly different from zero.

Becker and Gregg Lewis (1973) and Willis (1973) have also explored the implications for demand analysis of the multiplicative interaction between child quality and quantity that enters the household's budget constraint if it is assumed that to marginally change child quality, a parent must also change the quality investments in all intramarginal children.

11/ Ordinary least squares estimates of the structural relationship determining fertility will not have the desirable property of "consistency" unless all explanatory variables are uncorrelated with the disturbance in the fertility equation. Nor can lagged values of endogenous variables be treated as independent of the disturbance in relationships accounting for the same or related forms of current behavior, for well known reasons. For example, the probability that a woman works in the paid labor force will in general not be independent of the disturbance in the relation accounting for her fertility. Labor force participation patterns

Footnotes continued...

earlier in her life cycle are also influenced by observed and unobserved features of her environment that will be highly serially correlated, and that will continue to affect not only her labor force participation but also reproductive behavior. Clearly, individual tastes for children and more generally tastes for a wider array of market and nonmarket goods may be such an unobserved variable influencing both forms of behavior. In such a dynamic system of household behavioral relations, simultaneous equations estimators would appear generally appropriate for the study of structural equations determining fertility. 12/ For example, the systematic portion of the regime of mortality is determined by such slowly changing factors as long-term investments in public health, sanitation, water supplies and transportation, or geography and climate, or socioeconomic characteristics of the population. Thus, interregional differences in child mortality contain a relatively stable component over time. High positive serial correlation in regional differences in mortality implies that cross-sectional observations on mortality in any single time period contain substantial information about the persistent interregional differences that existed five, ten and perhaps even 20 years earlier. If the factors increasing mortality over the long term were associated with higher levels of fertility in the cross section, the positive observed relationship between child mortality and fertility would overestimate the direct short run influence of a change in child mortality on fertility. If the

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association between the long term determinants of mortality and fertility were causal, then the observed cross-sectional relationship between child mortality and fertility would also spuriously overstate the long run influence of mortality on fertility.

13/ It is a widely accepted and understandable belief that rapid population growth is responsible for socially wasteful externalities. But the hard analysis required to confirm this hunch is absent from, or surprisingly low on, the research agenda for economics.