AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY
Batch 77

1. SUBJECT CLASSIFICATION
A. PRIMARY: Population — PA00-0000-0000
B. SECONDARY: General

2. TITLE AND SUBTITLE
Fertility patterns and the "green revolution"

3. AUTHOR(S)
Robinson,W.C.

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1971	37p. 39p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS
Cornell

8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability)
(Prepared for Workshop on Food,Population and Employment: the Social Impact of Modernizing Agriculture,Cornell Univ.,1971)

9. ABSTRACT

10. CONTROL NUMBER
PN-AAF-188

11. PRICE OF DOCUMENT

12. DESCRIPTORS
Agricultural aspects
Economic factors
Fertility
Green revolution?
Population growth

13. PROJECT NUMBER

14. CONTRACT NUMBER
CSD-2823 211(d)

15. TYPE OF DOCUMENT

AID 590-1 (4-74)

FERTILITY PATTERNS AND THE "GREEN REVOLUTION"

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Prepared as a background paper for Conference, "A Widened Perspective of Modernizing Agriculture," Cornell University, June 1971.

Introduction

The inter-related series of changes in agricultural techniques and practices which have come to be called the "Green Revolution" have been widely discussed and analyzed. The hope arises that these changes constitute an "Asian Agricultural Revolution" which like the agricultural revolution in the West will be followed by an Industrial Revolution and an "escape trajectory" of cumulative economic and social development. But, these changes and these possibilities are all occurring in the shadow of the ever-present spectre of rapid population growth. The pessamists maintain that even large initial increases in agricultural output must eventually taper off and will, in any case, quickly vanish the pressure of a 2 to 3 percent population growth rate. On the other hand, if the increased agricultural output does give the developing nations a "breathing spell", perhaps there will be time for results to be realized from the growing emphasis on population control and family planning in these nations. Some well-informed observers are cautiously optimistic.[1]

This paper will attempt an assessment of these possibilities. In particular we will examine the probable consequences for fertility patterns of the "green revolution." First, we will sketch out briefly the present situation with respect to economic and demographic growth patterns around the world; we will review the economic implications of different fertility and mortality patterns, touching on in the process the considerable literatur which has grown up on the economic "cost" of excess fertility to the developin nations; we will next present a summary of the emerging body of propositions which can be called "the economic theory of family formation;" we will then make use of this micro-economic theory to discuss and present logical possible impacts on family fertility patterns of the economic changes associated with the

agricultural revolution now underway; finally, some implications are drawn for an optimum set of policies and also tactics to be employed by publically sponsored family planning programs in the developing nations.

Current World Population Growth

The present population of the world is thought to be slightly in excess of 3.5 billion and to be increasing at an annual rate of about 2 percent. These estimates are very rough because surprisingly little is known with certainty about population in the developing areas of Asian, Africa and Latin America.[2]

The sources of demographic data include: (a) registration systems under which births, deaths and other vital events are recorded as they occur; (b) periodic censuses in which population size and also characteristics are recorded as of a point in time; (c) sample surveys and/or pilot registration areas which produce estimates of what a national census and/or registration system would reveal or which at least permit some inferences to be drawn; (d) so-called "model" populations which summarize the experience of many populations for which historical evidence is available and from which estimates of the growth rate or the vital rates of the unknown population can be made given one or two of its parameters. The "developed" world typically can draw upon both registration systems and regular, reliable censuses and, indeed, both sources are needed if the flow of annual births and deaths and the stock of the base population are to be known accurately. Full-blown registration systems are operative in areas covering only about 29 percent of the population of the world and, in terms of major regions, the following estimate of the percent of the populations covered by vital registration was made in 1965:

Africa	3
Asia	9
Latin America	44
Oceania	78
Europe	100
North America	100

A recent census of population is available in areas covering some 70 percent of the total population of the world but if we insist upon having age and sex breakdowns of the total then the figure falls to under 60 percent. Using a variety of analytical techniques, the age and sex distribution from a census can be made to yield considerable amount of information also on probable fertility and mortality patterns of the population. Also, estimates of the vital rates for the nearly 40 percent of world population not covered by either registration or a census enumeration are often attempted on the basis of sample survey or the "model" population approach or some combination of the two. Thus, estimates of birth, death and growth rates do exist even for most African population, the region with the greatest absolute statistical deficiency. It must be understood clearly, however, that such "analytical estimates" are subject to a wide margin of error, as indeed are the censuses and even registration undertaken in rural, illiterate and poverty-stricken developing nations.

In any case, given all these limitations of the data and for what intrinsic merit they possess, the best estimates of present (1970) world population size, vital rates and growth rates, by region are shown in table I. Grouping the regions shown into "developed" and "less developed", we find that about one fourth of the 1970 total lies in the developed nations and that these populations display a birth rate of about 19.0 percent thousand and a death rate of about 9.0, for an overall average annual growth rate of 1.0 percent. The "less developed" populations, on the other hand, comprise some three-fourths of the total and are growing at an annual average

Table I

Population and Vital Rates
of the World, by Major Regions, 1970

	Mid-1970 Population (in millions)	Birth Rate	Death Rate	Annual Growth Rate
Africa	344.	47.0	20.0	2.6
Asia	2,056.	38.0	15.0	2.3
Latin America	283.	38.0	9.0	2.9
Oceania	19.	25.0	10.0	2.0
Europe	462.	18.0	10.0	0.8
North America	228.	18.0	9.0	1.1
USSR	243.	17.9	7.7	1.0
World	3,632.	34.0	14.0	2.0

Source: 1970 World Population Data Sheet, Population Reference Bureau, Inc., Washington, D. C., April 1970.

rate of 2.5 percent, being the resultant of a birth rate of 41.0 and a death rate of 16.0. A "medium" assumption project (assuming modest decreases in both fertility and mortality) to the year 1985 yields a world total of just under 5 billion persons.

Some of the other demographic and socio-economic characteristics of the present world population situation are worth noting in passing. For the "less developed" regions overall expectation of life at birth in 1970 was about 52 compared with about 70 for the "developed" regions. Thus, the "less developed" regions clearly have a considerable potential for further growth built into their presently high mortality rates. Were they to reach "developed" mortality patterns, with no change in fertility, their growth rates would increase by a third. The effect of the high fertility shows itself in the age distributions of the two groups of populations, too. Some 40 percent of the "less developed" populations are below 15 years of age, while in the developed regions it is only about 28 percent. Thus, the "dependency burden", the number of non-producers per producer, is greater in the "less developed" regions and, even if fertility should decline modestly, will remain so due to the increase in the older age groups as mortality continues to fall. The persistence of high infant mortality rates - 100 plus per 1,000 live births are typically in the "less developed" region - also makes for further potential growth since as this type of mortality falls it will have the same demographic impact as a rise in fertility, off-setting to some extent any decreases in fertility which may occur.

The Economic Cost of High Fertility

A substantial literature has grown up in recent years centering around the economic "cost" of high fertility to the developing nations. This "cost" is generally viewed as the depressing effect exerted by higher rather than lower fertility rates on future levels of per capita income. High fertility

will always have such a depressing effect unless it can be shown that: (a) the nation involved is experiencing increasing returns in production and can raise average output per worker by adding more workers; (b) the fact of population growth itself will cause technological change shifting upwards radically the future economic potential of the nation; (c) neither the level nor the allocation of total savings is affected by population size or growth rate. While some cases can perhaps be found which meet these criteria, they would seem to be exceptions in the developing world. Demeny, Enke and others have shown that the potential benefit per birth-prevented (or cost per birth not prevented) is equal for the typical developing country to two to three times per capita income.[4]

Most of these estimates of the "costs" of high fertility are derived from macroeconomic models of the entire economy and fail to make the important distinction between the "costs" to the procreating couples themselves versus the "externalities" or costs to society at large. Thus, the net cost to society of a marginal birth may be high measured in terms of the future requirements for education, health, capital equipment and foodstuff, but the immediate out-of-pocket costs to the family unit involved may be nil. And if we assign any value, either as a consumption good or as a productive asset, to the child, then there may actually be a net benefit to the family from even a high parity birth. We will develop this point at some length later on but it will suffice for now to note that the standard literature very often loses sight of this distinction between micro and macro and internalized versus external costs.

The Western Demographic Transition

It is important to see the recent expansion of population in the developing nations in proper context, as only the latest phase in a world-wide modern "explosion" of population. Durand has summed this up very well:[5]

> Mankind is undergoing an extraordinary expansion of numbers, unparalleled in history, which began in the eigteenth century and which has gathered increasing momentum since the beginning of the present century. The increase of the earth's human population during the last two hundred years has been three times greater than the cumulated growth during all the previous millennia of man's existence on the planet, and it appears likely that a still greater increase may be in store for the future, before a position of numerical stability is reached. The speeding up of population growth has been brought about by a great improvement in the conditions of mortality, which has enhanced the biological power of multiplication of the species. This has been partly offset in the economically more developed countries by restraint of reproduction, but reproduction rates remain undiminished in most of the less developed countries. The latter countries contain the major share of world population and are receiving an even larger share of the current increase resulting from the excess of births over deaths throughout the world. The crux of the world population problem is in the association of persistent poverty and technological retardation with unremitting rapid growth of numbers in the less developed countries.

Durand is also our source for the following table indicative of the general historical trend in world population:

	World Population (in Millions)		Annual Average Growth Rate
1750	791		
1800	978	1750-1800	0.4
1850	1,262	1800-1850	0.5
1900	1,650	1850-1900	0.5
1950	2,515	1900-1950	0.8
1965	3,281	1950-1965	1.8

A somewhat deeper look into the regional breakdown of these world aggregates indicates that some interesting changes have been occurring even while the overall trend has been uniformly upwards. In the early modern period of growth, 1850-1900, the areas making up what we have been calling the "less-developed" nations - Africa, Asia and Latin America - were not growing in population to speak of, while the nations of the "developed" areas - North America, Europe, Oceania - grew at an annual average rate of 1.0 percent or better. During the period 1900-1950 the two regions grew at about the same rate and by the beginning of the post-World War II period the "developed" nations were growing at rates well below those of the "developing" world. This "cross-over" in relative growth rates between the two regions has, to repeat, occurred because the growth rates of the "less developed" regions have everywhere risen while the growth rates of the "developed nations" have been falling. The post-World War II rise in fertility in most Western Countries - the so-called "baby boom" - can now be seen in retrospect as a relatively minor deviation from the long-term declining trend in fertility. One important implication of these trends is, as already noted, for the percentage of total world population represented by the "less developed regions" to increase. Of the total growth in the 1850-1900 only 44 percent occurred in these areas. By 1900-1950 about 70 percent of the growth took place in the "less-developed" regions. Projections of the future indicate that over 80 percent of all future growth will be these areas.

Thus, while it is as we have noted generally accepted that the present high rates of population growth in the developing world are at odds with the goal of rapid economic growth, the historical picture suggests that rapid economic developed and rapid population growth went hand-in-hand for Europe. Simon Kuznets has summed up this evidence as follows:[6]

> From 1750 to the 1920's and 1930's, the rate of population growth was distinctly higher in those areas that we now consider economically developed than in the rest of the world. The area of European settlement, perhaps excluding Latin America, can be roughly identified as the main area of development; it excludes only Japan among the industrialized countries and includes only relatively small (proportionately) population groups that are not fully developed (in Southern and Eastern Europe and in Oceania). From 1750 to 1920 the rate of population growth in this developed part of the world, which accounted for 21 percent of world population in 1750 and for 34 percent in 1920, was distinctly above that in the rest of the world. It was only after 1920, and particularly after 1930 that the rate of growth of population in the less developed areas exceeded that in the developed areas. Since the rates of growth of per capita income in the developed areas from 1750 to 1920 far exceeded those in the rest of the world, there was, until the 1920's, a positive association between population increase and the increase in per capita (and, of course, total) product.
>
> To be sure, this is a crude association limited to the broad dichotomy between developed countries and the rest of the world. It does not hold for individual countries within the developed group: France and Sweden, for example, with moderate rates of population growth had rates of growth in per capita product that compared favorably with others; and Australia, Canada, and even the United States, with high rates of population growth had rates of increase in per capita product that, while substantial, were not among the highest.
>
> And it would be easy to list a number of countries in Latin America, Eastern Europe, and Asia, with high rates of population growth and little or no increase in per capita income. Nor does the association hold over time in the course of modern economic growth in a single country. To be sure, if such growth begins in an old country (rather than a young and empty country, usually overseas) it often follows or is

> accompanied by an acceleration in the rate of growth of population; and in that sense there is for a while a positive association between the rate of population increase and that in increase in per capita product.
>
> Despite these qualifications it is important that through most of the long period of modern economic growth, the areas of the world that became developed were also the areas in which the rate of population increase was high, compared with that in the rest of the world and with the rate in these developed areas before the initiation of economic modernization.

The demographic movement in European populations has thus been from low to high to low growth over the course of about two hundred years. This experience has been referred to as the "vital revolution" or more commonly, the "demographic transition." This "transition" is summed up by Coale and Hoover as follows:[7]

> The agrarian low-income economy is characterized by high birth and death rates -- the birth rates relatively stable, and the death rates fluctuating in response to varying fortunes. Then as the economy changes its form to a more interdependent and specialized market-dominated economy, the average death rate declines. It continues to decline under the impact of better organization and improving medical knowledge and care. Somewhat later the birth rate begins to fall. The two rates pursue a more or less parallel downward course with the decline in the birth rate lagging behind. Finally, as further reductions in the death rate become harder to attain, the birth rate again approaches equality with the death rate and a more gradual rate of growth is reestablished, with, however, low risks of mortality and small families as the typical pattern. Mortality rates are now relatively stable from year to year and birth rates -- now responsive to voluntary decisions rather than to deeply imbedded customs -- may fluctuate from year to year. This short description fits the experience of most countries whose economies have undergone the kind of reorganization we have been calling economic development.

> The theory of the demographic transition has been summarized here because it is the theory which seems to be the best available to describe the expected course of events in the low-income areas of the world today if their economies are developed. Shall we not expect that economic development in the contemporary low-income areas will bring with it a decline in death rates followed by a decline in birth rates, and will produce over an interim period an acceleration of population growth?

Thus, "transition theory" is a completely empirical proposition based on the historical experience of a handful of Northern and Western European Nations. The implicit assumption is that there exists some natural tende for populations to go through a cycle to low to high to low population grow as they experience the basic restructuring of their economic and social institutions which is called "development." Declining death rates indicate that a nation has entered phase I of the "transition"; declining birth rate or even evidence of appreciable fertility differentials among social and economic classes, are evidence of having arrived in Phase II; when both birth and death rates are low and approaching some rough kind of balance, the nation is entering Phase III. Bogue computes, on this kind of basis, an index of what percentage of the world's population has completed its "transition." Asia and Latin America have clearly entered the first phase and are confronted with rapidly falling death rates and consequently rapidly rising populations. Africa is only just now entering this phase and has its greatest growth potential some years ahead of it. The "optimistic" cases of some North Asian countries - Korea, Japan, Taiwan - in which fertility ha also fallen suggest that Phase II has been reached for at least this handful of populations.

The heart of the "theory of the demographic transition" is an implicit glimpse of rational economic-demographic man. Van Nort has summed this up nicely:[8]

> Our proposed formulation can be put very simply and crudely as follows: the transition from "high" to "low" levels of fertility represents, in first approximation, a transition from a biological model of fertility to an economic model of fertility. By a biological model of fertility we mean the ideal-type situation in which levels of fertility are determined by the more or less direct operation of biological factors, conditioned by a set of social and psychological factors specific to a preindustrial society. By an economic model of fertility we mean the ideal-type situation in which levels of fertility are determined by decisions based on the rational allocation of resources among competing wants of the type normally denoted economic, conditioned by a set of social and psychological factors specific to a modern industrial society. The transition in fertility represents, in terms of this particular formulation, the gradual limiting of biological de terminants of fertility by a process of rational decision-making.

This implicitly economic picture of the "transition" process has characteristic of nearly all writings on the subject. However, it has been the sociological or the psychological interpretations which have usually been stressed. In fact, it is perfectly possible to show that the low to high to low population growth trends result from a very simple cost-benefit maximizing model of the microeconomic decision-making unit. It will be main burden of the balance of this paper to elucidate such a model, capable we feel of explaining the observed demographic trends in the Western Transition and also possessing of some predictive power regarding the future of the developing nations.

An Economic Theory of Family Formation

The conventional economic theory of consumer behavior is familiar to even casual students of economics. The consumer is viewed as pursuing a maximization of his total satisfaction, given a range of goods from which to choose, given also their relative prices, and given his own tastes and income. This apparatus can be adapted so that children are introduced as a special kind of "goods" generating both consumer satisfaction directly and having

some investment-like characteristics as well. There are costs connected with acquiring and maintaining these assets, and the satisfactions and returns from various possible quantities can be balanced off against the costs. Leibenstein, in his classic Economic Backwardness and Economic Growth, first published in 1957, noted the serveral types of "utility" that a birth might generate for parents:[9]

> The types of utility are: (1) the utility to be derived from the child as a consumption good, namely, as a source of personal pleasure to the parents; (2) the utility to be derived from the child as a productive agent, that is, at some point the child may be expected to enter the labor force and contribute to family income; and (3) the utility derived from the prospective child as a potential source of security, either in old age or otherwise.

Leibenstein also touched on the question of the costs of children to the family, as follows: "The conventional costs of child maintenance increase as per capita income increases. The style in which a child is maintained depends on the position and income of the parents; therefore, we expect such costs to rise as incomes rise. The indirect costs are likely to behave in a similar manner."[10] By indirect costs he makes clear elsewhere that he has in mind among other things the opportunity cost; that is, the decrease in family income due to a reallocation of some part of the total potential time and effort available to the household away from gainful economic activity due to childbearing and childrearing. Thus, the consume arrives at some kind of optimum. This decision-making process proceeds in the light of the relative costs and returns from other types of purchases that compete with the acquisition of children.

Put thus bluntly, the model may evoke either a snicker at its naivete or outrage at the cold, unfeeling mind that could suggest that children somehow compete in the minds of their parents with a new car or a bigger house.

Yet neither of these criticisms is well-founded. To begin with, the model is obviously restricted in its applicability to couples who do plan their families -- who have some fairly clear idea of how many children they want and who then employ whatever technology is available to reach that number. Thus, persons who do not practice any kind of meaningful contraception either because of religious belief or because of ignorance or indifference are not going to be "well treated" by this model since they are not truly "planners." However, most people in the developed nations are "planners" even if they are not 100 per cent effective in reaching their goal and even if the goal itself is a shifting one through time. There is evidence that many couples in the developing nations also have far fewer children than they are biologically capable of having, and there is thus reason to believe that some planning occurs there too.

The second criticism suggested above can be answered in the same terms. While the desire for offspring is clearly widespread and powerful, the fact that planning of families does occur suggests that a rational balancing of children against other sources of satisfaction also occurs. That, in nearly all cultures, couples undertake to have fewer children than nature might otherwise provide suggests that there are other goals that are competitive with the desire for parenthood.

Many families -- perhaps most families in the developing areas -- do not appear to plan at all, which may indicate that the satisfaction from ever very large numbers of children remains a positive factor. However, such apparent lack of planning may really indicate only inefficient planning - frequent unwanted pregnancies and births -- due to exclusive reliance on relatively ineffective "folk" methods. There is also a category of non-planners made up of tradition-bound men and women who, given their religi and ethical beliefs, and given varied levels of income and contraceptive expertise, simply do not have meaningful access to family planning.

Even given that the planning is uncertain and given that the costs and satisfactions involved are subtle, it still seems reasonable to think of couples as making a "maximizing" decision and choosing their family size in much the same way that they make other household economic decisions. This is the basic assumption of an emerging point of view that can be called an "economic theory of fertility."

This model may be illustrated very simply as shown in Figure I. Curve OO' represents the total (and fixed) resources available to the family unit. (This can be interpreted as total hours per the relevant planning period; or converting all hours to dollars at the going market wage for all adults in the planning unit it can be thought of as full potential income in Easterlin's sense.)[11] The two vertical axis both measure net marginal benefit (or utility) per resource unit expended. Function DD' is the marginal value of resources devoted to consumption of non-children related goods and services including leisure. Function BB' is the same type regarding the return from children. Note that this returns curve does not directly measure family size. It seems reasonable to assume that total resources expended on children would be directly related to family size and that consequently the OO' axis could be laid off as number of children for the purposes of the BB' function. However, it is not clear that each additional child would represent the same distance along OO' since marginal cost per child might not be constant. Also, the cost per child would definitely be related to the quality objective of the family, as this concept is used by Becker and others, and the distance along OO' per child would be different for different families.

In any case, the equilibrium allocation of total resources between the two possible uses - consumption and children - is reached when the

marginal return to the last unit of resources devoted to each of the two is the same. This is point E, where the marginal returns = OF and O'G are the same, and OE resources go to children and EO' to consumption. The picture can be made a bit more realistic by allowing for leisure as a separate and competing possible use of resources. The leisure must have a marginal value higher than OF = O'G to be pursued at all. Make this OH (=O'i) in Figure 1, in which case we move back up both BB' and DD' until the marginal returns from children and consumption are also equal to the assumed marginal value of leisure of OH (= O'i). At this point, OJ resources go to children, JK to leisure and KO' to consumption. Total resources are exhausted and the marginal return per unit of resource employed is equalized in the three possible uses.

The effect of increasing the marginal value of either leisure or consumption on the purchase of children is thus seen as competitive. At some very high level of D'D or of the return from leisure OH, the point E would be very much closer to origin (

Major Theoretical and Empirical Findings

Let us review briefly some of the major theoretical and also empirical works done within the framework of the above model

Gary Becker in a 1960 paper developed these same notions into what is probably the first statement of an economic theory of fertility.[12] There are two central themes in Becker's argument. First is that people decide how many children they will have in much the same way that they purchase a consumer durable. In both cases, present and future returns are balanced against costs and a decision is made on rational grounds. He observes that people, in general, purchase more durables as their income goes up and they probably also desire more children as their income increases. The widely-observed inverse relationship between actual fertility and income Becker

attributed mainly to the lack of contraceptive knowledge and technique among low-income groups. Using examples from a variety of settings, he is able to satisfy himself that where contraceptive knowledge can be standardized for, a positive relationship emerges between income and fertility.

Secondly, Becker argues that, in any case, the product which people are purchasing when they plan their desired number of children is children of a certain quality. Thus, the parents are deciding not only how many births are desired but also what quality of children these births will represent. This quality factor is elusive and troublesome. Becker says "high quality" children entail greater expense - more living space at home to provide separate bedrooms, nursery schools and private colleges, music lessons, more frequent medical and dental care, and so forth. Allowing for this qualitative dimension, he argues that the spending on children definitely rises with rising income (or, in more technical terms, that the income elasticity of demand for children is positive).

Thus, that cost per child is much greater for high-income (and low-fertility) groups cannot be used to explain why they purchase fewer children. They are purchasing children of a higher average quality but the cost per unit of high-quality children is the same for all purchasers. To put the matter differently, Chevrolets and Cadillacs are considered low and high quality automobiles, respectively, having prices which are market determined and the same to all prospective buyers, low-income and high-income alike. If high-income persons choose to buy Cadillacs and low-income persons choose to buy Chevrolets, this is attributable mainly to the income differentials not to the price differences between the two automobiles. Thus, Becker argues that high-quality and low-quality children are in some sense available to high - and low-income persons alike. Low-income groups choose (or perhaps

end up purchasing because they have no effective choice) larger numbers of low-quality children, while higher-income groups choose a smaller number of higher-quality children. The actual spending of the higher-income group on children will almost certainly be greater than the spending of the low-income group. Thus, demand is correlated positively with income, and since the two groups are buying different products the relative prices of low - and high-quality children do not affect the demands. In sum, Becker says:

> To put this differently, social pressures may affect the income elasticity of demand for children by rich (and poor) families but not the price elasticity of demand. Therefore, the well-known negative relationship between cost (or price) and quantity purchased cannot explain why richer families have had relatively few children.[13]

Becker's conclusions are provocative because they run exactly counter to the central conclusions of a generation or more of demographic research - namely, that higher income means lower fertility. Becker limited the applicability of his model by stating that "there are no very good substitutes for children," implying that the demand for children was somehow unique and not affected by relative costs of obtaining these assets compared with other assets or the relative benefits from these assets versus other assets. Thus, by ignoring prices and by shaping his entire presentation to show that children are a unique, noninferior "good," Becker in our judgment fell short of a full economic theory of fertility.

The next important theoretical step was taken by Jacob Mincer in 1963.[14] In developing the notion of the general importance of opportunity costs (the income or returns foregone when we decide to do one thing rather than something else), and price and income effects for statistical studies of demand for a wide range of products, Mincer took as one illustration the demand for children. His major argument was that a cross-sectional study

could afford to ignore the cost (purchase price) of children since it is constant for all income groups and families, while the same is not true of opportunity costs. Measuring opportunity costs as the foregone wages of the wife who bears and cares for children rather than working, and using a sample of 400 employed, urban white families, he fitted the following form of a demand equation:

$$X_o = \beta_1 X_f + \alpha X_2 + \beta_3 X_3 + \mu$$

in which X_o is fertility, X_f is sum of husband's and wife's full-time earnings, X_3 is level of contraceptive knowledge measured by "years of husband's schooling," and X_2 is wife's full-time earnings. He found that

$$X_o = .10X_f - .19X_2 - .02X_3.$$

Thus, his results were consistent with the assumption that the income effect on fertility is positive; the relationship with opportunity costs, negative; and contraceptive knowledge, cutting across income and opportunity costs, exerts a negative effect as well. (The variation in his dummy variable for contraceptive knowledge was small, thus undoubtedly explaining the very low coefficient obtained.) This approach made no effort to look at relative costs of children for different income groups or at the reasons for various sizes of family other than, as noted, opportunity costs.

The most recent theoretical contribution is contained in a paper by Easterlin.[15] Reviewing the earlier literature, Easterlin argues that a "permanent income" concept is more relevant to the fertility decision than is mere currently measured income. The idea of permanent income was introduced into economic analysis by Milton Friedman and is defined simply as: "the income to which consumers adapt their behavior - which we term 'permanent income.'"[16]

Easterlin argues for an even broader definition of the income variable and includes not only what he calls "prospective" income but also a measure of the opportunity income foregone. Thus:

> Even if there were no difference between prospective annual income and that currently observed, the potential income of a household would exceed its observed income, for the simple reason that typically money income is foregone in order to have time for the other pursuits. Observed income may be an unreliable index of potential income because it inadequately reflects not only prospective earnings through time but foregone earnings at a point in time as well.[17]

Thus, Easterlin posits a "potential income" as the appropriate income variable affecting fertility. He agrees with Mincer that the wife's forgone income is one kind of price of children but also indicates that the cost of hiring child care - day nurseries, for example - would also enter in. He agrees with Mincer, however, that the sign attaching to the price-fertility relationship is almost certainly negative.

Easterlin's greatest contribution to moving forward the theory of family formation is to put competing goods back into the picture. He does this through the notion of tastes. Thus, he says taste for, or relative intensity of desire for, children must be evaluated in the light of tastes for and desire for other goods at the same time. "The strength of a household's desire for any given good, say, children, must be evaluated in the context of its attitude toward other goods." Misinterpretation of this simple fact has led to much misunderstanding concerning responses to survey questions about desired family size. Even given his income, until we know what the consumer's tastes are for other goods that compete in his mind with children, we cannot be sure we are isolating the taste factor.

There is, Easterlin notes, a well developed theoretical framework in economic analysis for showing how such choices among alternatives that are subject to constraints occur.

> In general, one's preference system at any given time may be viewed as molded by heredity and past and current environment. The process starts with birth and continues through the life cycle. Religion, color, nativity, place of residence, and education enter into the shaping of tastes.[18]

Although economic demand analysis frequently assumes that tastes are essentially noneconomic in their genesis and that they remain relatively fixed over time, this assumption will not be valid for fertility theory, Easterlin says. Tastes and preferences are partly determined by income and in turn interact with income since some choices to be made now have a bearing on income in the future. Similarly, tastes for children have shown variation among the generations and will continue to do so, regardless of what the overall trends may be.

Finally, Easterlin calls attention to an interesting and overlooked aspect of the fertility-consumer demand theory relationship, which is that demand for children is actually a joint demand, the other commodity involved being the act of coitus. Now, demand for children can logically be separated from the demand for coitus since adoption is possible. Similarly, the demand for coitus does not imply any demand for children. In totally unplanned, noncontracepting family situations, the two products are linked very strongly. The couple must judge how much coitus they wish to enjoy in the knowledge that the benefits and also the costs of the joint product, children, will probably be theirs too. What contraception, and in a deeper sense the entire demographic transition, is all about is breaking this link. But so long as contraceptives vary in effectiveness, acceptability, cost, and the effort required by the user, a decisional element remains for the couple. Is the time, trouble, and cost of contracepting, of breaking this link, greater than the expected net cost of the joint product, children? Deciding this question has direct bearing on the other decision which usually receives attention --

that is, how many children does the couple want? For, in some cases, the children are wanted only in the sense that the costs of preventing them outweigh the costs of having them.

A variety of other empirical studies having been attempted in efforts to isolate and measure the strength of this economic factor bearing on fertility. These include recent papers by D. Freedman, R. Freedman and L. Coombs, Kunz, Stafford, Judith Blake, K. Namboodiri, and Cain and Weininger.[19]

Implications For The "Green Revolution"

Let us summarize the argument thus far. World population growth began first in the Western sphere of civilization and occurred in association with a series of economic and social transformations. There is evidence that fertility rose in at least the early stages of the process, but over the longer run the rise in real incomes seems to have caused declines in fertility. Most demographers would assume that the inverse relationships between fertility and income is a nearly inevitable trend. But, it is important to remember that this relationship in the West was also filtered through urbanization, a changing occupational structure of the labor force, and many other important changes.

At the microeconomic level, we have argued that the emerging economic theory of family formation provides a valuable guide to the behaviour at the family level which produced the observed macroeconomic changes in birth rates. In particular we have suggested that the family can be thought of as making a deliberate, maximizing choice with regard to family size after a balancing of costs and benefits of alternatives. The planning in pursuit of the objective may not be very efficient, but this too can be seen as a matter of rational cost to benefit calculation.

The implications of this model of actual fertility behaviour are that the factors affecting fertility the most are the subjective economic return from children to be recieved by the family, the relative returns available from other possible sources of income and satisfactions, and the costs of the children. Using this model it is now possible to consider the implications on fertility and on consequent population growth of the changes in real income which we can assume will flow from the "green revolution".

Let us use, for this analysis, another version of the convention indifference curve apparatus of micro economics and sketching out three hypothetical cases. Case I, is illustrated by Figure 2. Curves T_1, T_2, etc., are a family of isoutility (or trade-off) curves representing locuses of equal total satisfaction from the two presumed ways people derive enjoyment - material goods and children. Thus, points a and b on T, represent equal welfare arrived at by different combinations of the two goods. Curves I_1, I_2, etc., are various income levels the intercepts of which mark off the absolute limits of the consumers ability to consume either one output (0^c material goods, 0^h children). The equilibrium, or "right" combination is at g where I_1 and T_1 are tangent. This represents uniquely the highest T curve available subject to I_1 income constraint. Point h represents the same equilibrium for income I_2. The increase in income from I_1 to I_2 thus increases size of family chosen from Oe to Of. This would indicate, then the case in which in income elasticity of demand for children is positive and rising incomes mean an increase in desired family size. However, it can easily be shown that this result follows from the assumed shape of the preference surface in Figure 1 (the relationship of T_1 to T_2, etc.) and also the way in which increases in real income reflect themselves in movements along the two axis (the Oc, Oi and Od, Oh intercepts).

The crux of this case is that total income increases for the family unit with no change in the marginal utility of either consumption or children. This is the same thing as saying that the utility surface is smooth and symmetrical with respect to the origin. This would indicate that the increase in income would result in increases in the consumption of both children and material goods. Increased fertility might then be the result to the extent that any deliberate restriction of family size had been occurring prior to

this time. Cases in which age at marriage, employed as a regulator to keep family size within the desired bounds, has fallen with increasing economic progress are examples of this case. The much discussed case of the population increase in Ireland which followed the introduction of the potato also comes to mind. This case very definitely has neo-Malthusian overtones: population increase follows a rise in the standard of living. But, it is a more defensible version of the essentially Malthusian model because it makes fertility the regulating device not mortality. Mortality changes may be associated with changes in income and standard of living but due to the intervention of modern public health measures the link is much weaker and more uncertain than was perhaps the case during European development. In fact, both interact. The result is that the increased levels of living bring an increase in actual fertility. As we noted above there is considerable evidence that fertility did, indeed rise in the early stages of the Western Demographic "transition" and there is also some scattered evidence to suggest the same kind of positive association between economic development and fertility in the present developing areas.[20]

Case II - Case II is illustrated by Figure 3 which shows a unit for whom the trade-off of material goods to children changes as levels of both increase. The preference surface is, in short, not a smooth regular surface but instead shows a skewedness towards the material goods axis. In this case, as income rises, we find our successive changes between I_1 and T_1, I_2 and T_2, etc., indicating smaller and smaller family sizes - oa to ob to oc. Thus, the increase in income does not generate a scalar increase in fertility but rather a reduction past a certain point. Notice that this pre-supposes that there exist a growing volume of uses for the income which are competitive with children - manufacturers, investment goods, services, etc. - and also that the increase in income is in the form that lends itself readily to use for these non-children goods; that is, in cash income rather than a simple increase in the level of subsistence. This is an important point to which we return below.

Case III - The "cost" of children is measured in this model by the amount of material goods and services satisfactions which must be surrendered by the decision making unit when they are chosen. In other words, it is assumed that income is such that it can be used for children or for non-children satisfactions. As we have seen, there is also the question of "quality" per child to be dealt with. "Quality" means the education, health care, special housing and food and the like with which the child is equipped. It represents a measure of the investment per child by the parents and it can

vary widely. It seems reasonable to think that it rises with income; that is, that high income families invest more per child than low income families and this is the same thing as saying that the marginal cost per child rises with income. In terms of our earlier list of items which enter into cost of children such factors as out-of-pocket costs of schooling, the "opportunity" cost of childcare by some adult member of the family, the loss of leisure time all seem relevant. Thus, with increasing income levels, demand for children may not rise if the cost of children compared to other things rises even faster.

Figure 4 illustrates this possible relationship. Here the cost additional increases in family size rises sharply as we increase real income. The changing slope of the income line illustrates this. The cost of od children was og goods, but the cost of de additional children is gh, an obviously greater unit cost. Similarly, the increase ef in children. The result is that, even with the smooth surface to the T_1, T_2, T_3 trade-off curves portrayed in Figure 1, the desired family size tends to fall as income goes up - oa to ob to oc.

The model of the "demographic transition" in Western European populations argues implicitly that it was a combination of Cases II and III; that preferences turned against children as a rising volume of competing consumer goods and services became available to the increasingly urbanized, literat and educated population and that the cost of children tended to rise along with the trend increases in real income per family unit. Thus, fertility declined as income rose.

Conclusions

Now, at last, we reach the heart of our own present consideration: which of these Cases (or what kind of combination) will best describe the

impact of the increase in real incomes now occurring in the developing nations as traditional agriculture begins to modernize? The question cannot be answered with any certainty but the foregoing analysis does make it possible to at least enumerate and discuss some of the major elements in the present situation which will shape the answer

First, the distribution of the benefits from the modernization within agriculture is important. If we can broadly and perhaps artificially divide the agricultural sector into market-oriented and subsistence, then it is likely that improvements in the productivity of the subsistence farms will result in changes such as those described in Case I above. The increase is an increase in the ability of the unit to feed itself and the per capita consumption of existing members will rise and, because of both decreased mortality and increased fertility, the number of members may also rise. Subsistence farms, almost by definition, are not likely to be well described by our Cases II or III since their income is not tradable to other sectors for competing consumer goods and since most of the costs of children simply do not apply. Thus, an improvement in the standard of living of the subsistence sector is likely to cause an increase, temporary perhaps but real all the same, in population growth. On a little reflection this should not really be so surprising since it is typically this sector of most populations which is the high fertility group, long after fertility declines have set in the other sectors and even elsewhere within agriculture. The examples of the marginal subsistence farms of the American South and Southeast come to mind as do the subsistence Ejidoes of Mexico.

Second, the market-oriented farmers are more likely to experience the situations described in Cases II and III above, namely increasing costs of children and increasingly available competing goods. However, this will be

more true for the units of the middle income range since very large, pros perous farmers will not in fact feel the constraint to maximize keenly. They can afford large families and still afford ample supplies of other goods even in the face of rising costs of children. The relatively high fertility of the very rich even in the United States supports this interpretation. The fertility is likely to be decreased by increases in the productivity of agriculture to the extent that the improvements are concentrated in the small to middle size and income farms which are market-oriented, which have begun to consume the output of manufactured goods and for which the costs of children have become a relevant consideration.

Third, measures designed to increase the cost of children - compulsory education, child labor laws, increasing the labor force opportunities of females, etc. - will all have a favorable effect on fertility particularly in the face of rising income levels. Measures such as these should be made part of the family planning program even though they have not typically been so up to now.

Fourth, excessive austerity in development may be self-defeating. Our model suggests that allowing income levels to rise, especially when such rises are accompanied by a growing awareness of the benefits and delights of transistor radios, aluminum cooking pots, umbrellas and so on, should result in declines in fertility after some point. (It can also be argued the other way around that without such trickling down of aspirations and economic horizons, fertility is likely to remain high. Both our Cases II and III can be seen as working in reverse too.

The foregoing discussion has been at a very high level of abstraction and this may seem to affect the meaningfulness or the applicability of the model and our deductions therefrom. This need not be the case, however. The model need not be applied only to national populations. It can be applied to sectors, economic classes or subgroups within a population and can go a long way towards explaining fertility differentials within an apparently homogeneous

underdeveloped nation. It probably also helps our understanding of why the tempo of the demographic transition in the West was so different from one country or region to another and why high fertility persisted in some areas but not in others.

The greatest liklihood, it seems to me, is that much of the Western "transition" experience will indeed be repeated in the developing world. As income levels rise, fertility may also rise for a time. But, if income continues to rise and if there also occur the concomitant changes in social and economic settings which we have suggested result in increasing competing goods and also the cost of children, then we see no reason to doubt that fertility will begin to decline. But, it also is well to remember that this adjustment process, this learning period took several generations in the West, about one generation in Japan and perhaps ten to fifteen years for Taiwan and some of the other early "successes" in the developing world. Perhaps this can be cut down a bit more, but perhaps it cannot. Raising agricultural productivity is the first step towards the complete modernization of the traditional societies. The second step is the creation of viable domestic industrial sectors and the creation of an "achieving" frame of mind. Fertility reduction is likely to come as step three or even four in this process, perhaps ten to twenty years after the initial breakthrough in productivity. Some would say this will be too late and that fertility declines will not matter that far in the future. I disagree, but in any case we have no choice. There is no cheap and easy path to fertility reduction. Our own simple model makes this clear as does the whole weight of much experience in fertility reducting programs by government around the world. Fertility reduction follows economic development, not the other way around.

Footnotes

1. On the pessamistic side, see: J. J. Spengler, "Agricultural Development is Not Enough" in: World Population - The View Ahead, edited by Richard N. Farmer, John D. Long and George J. Stolnitz, Graduate School of Business, Indiana University, 1968, pp. 104-126; Robert C. Cook and Jane Lecht, People! An Introduction to the Study of Population, Columbia Books, Publishers, Washington, D. C., 1968; there are also numerous works by well-known popularizers such as Paul Erhlich and Garrett Hardin. On the more optimistic side: Donald J. Bogue, "The End of the Population Explcsion," The Public Interest, No. 7, Spring 1967, pp. 11-20; Frank W. Notestein, "The Population Crisis: Reasons for Hope," Foreign Affairs, October 1967.

2. This section is based largely on the most recent United Nations projections (World Population Prospects, 1965-85, as Assessed in 1968, Population Division Working Paper No. 30, December 1969) and on the definitive historical series complied by John Durand ("The Modern Expansion of World Population," Proceedings of the American Philosophical Society, Vol. 111, No. 3, June 22, 1967), pp. 136-159.

3. See: Nathan Keyfitz and Wilhelm Flieger, World Population: An Analysis of Vital Data, Chicago: University of Chicago Press, 1968, pp. 4 ff.

4. These questions are discussed at length and the relevant literature cited more fully in: Warren C. Robinson and David E. Horlacher, Population Growth and Economic Welfare, Report on Population/Family Planning Series, The Population Council, New York, April 1971.

5. John Durand, "A Long-Range View of World Population Growth," World Population, The Annals of the American Academy of Political and Social Science, Vol. 369, January 1967, p. 1.

6. Simon Kuznets, "Demographic Aspects of Modern Economic Growth," World Population Conference, 1965, pp. 5-6.

7. Ansley J. Coale and Edgar M. Hoover, Population Growth and Economic Development in Low-Income Countries, Princeton: Princeton University Press, 1958, p. 13.

8. Leighton Van Nort, "Biology, Rationality and Fertility: A Footnote to Transition Theory," Eugenics Quarterly, Vol. 3, Sept. 1956, p. 158. For elaborations of this version of the "transition" see: James M. Beshers, Population Processes in Social Systems, Free Press, 1967, Chapter 2; also Alfred Sauvy, General Theory of Population, Basic Books, 1969, Part II.

9. Harvey Leibenstein, Economic Backwardness and Economic Growth, New York; Wiley, 1957, p. 161.

10. Ibid, p. 164.

11. See: Richard Easterlin, "Toward a Socio-Economic Theory of Fertility." in L. Corsa, et al., editors, Population and Family Planning: A World View, Ann Arbor, 1970.

12. Gary Becker, "An Economic Analysis of Fertility," in: Demographic and Economic Change in Developed Countries, National Bureau of Economic Research, 1960.

13. Ibid, p. 215.

14. Jacob Mincer, "Market Prices, Opportunity Costs and Income Effects," in Measurement in Economics: Studies in Mathematical Economics and Econometrics, C. Christ, et al., editors, Stanford, 1963.

15. Easterlin, op. cit.

16. M. Friedman, A Theory of the Consumption Function, Princeton, 1957, p. 221.

17. Easterlin, op. cit., p. 132.

18. Easterlin, op. cit., p. 135.

19. These and other references are cited and discussed in W. Robinson and D. Horlacher, op. cit.

20. See, for example: David M. Heer, "Economic Development and Fertility," Demography, Vol. 3, No. 2, 1966.

FIGURE I

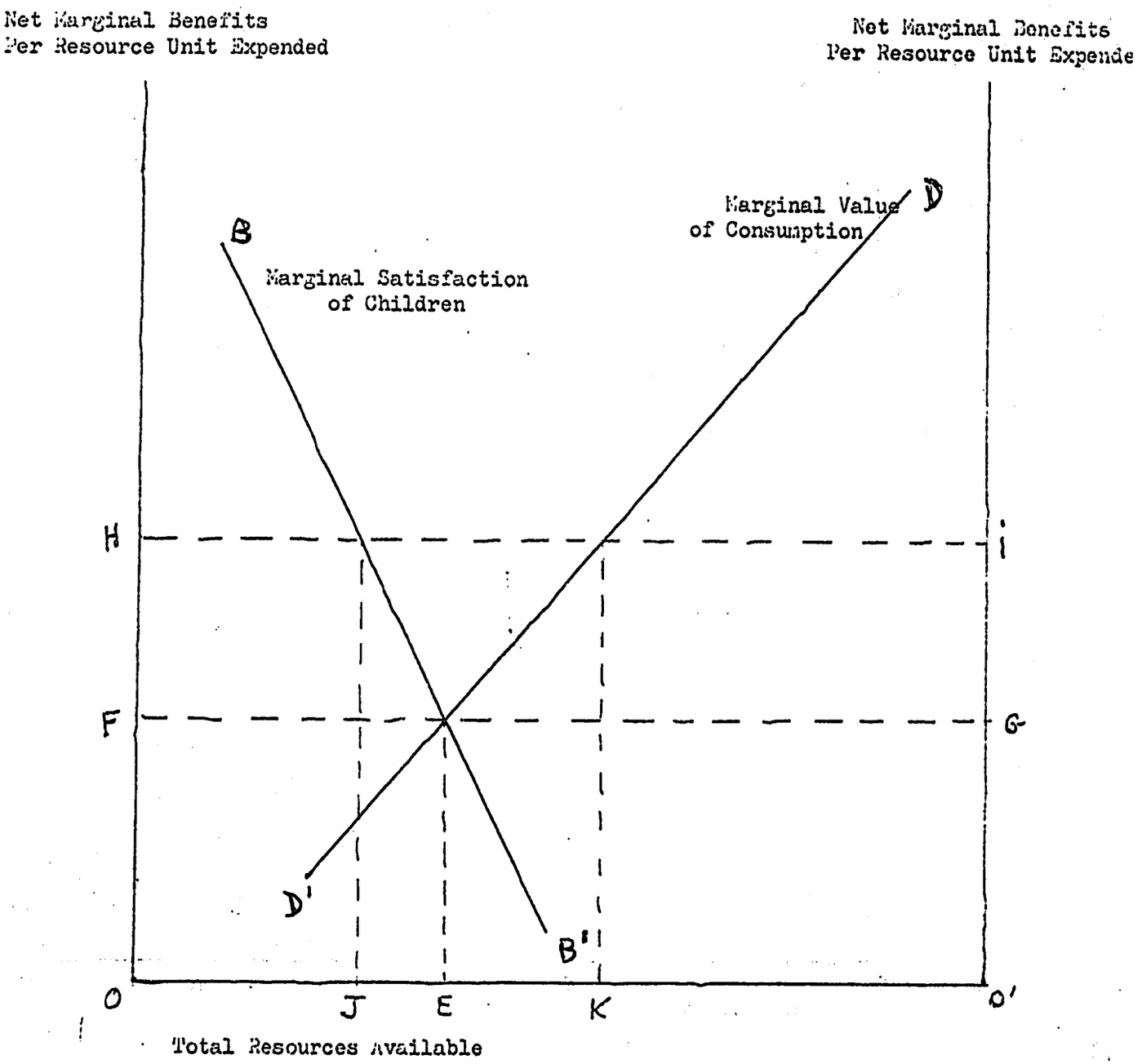
Net Marginal Benefits
Per Resource Unit Expended
Net Marginal Benefits
Per Resource Unit Expende
B
Marginal Satisfaction
of Children
Marginal Value
of Consumption
D
H
i
F
G
D'
B'
O
J
E
K
O'
Total Resources Available

FIGURE II

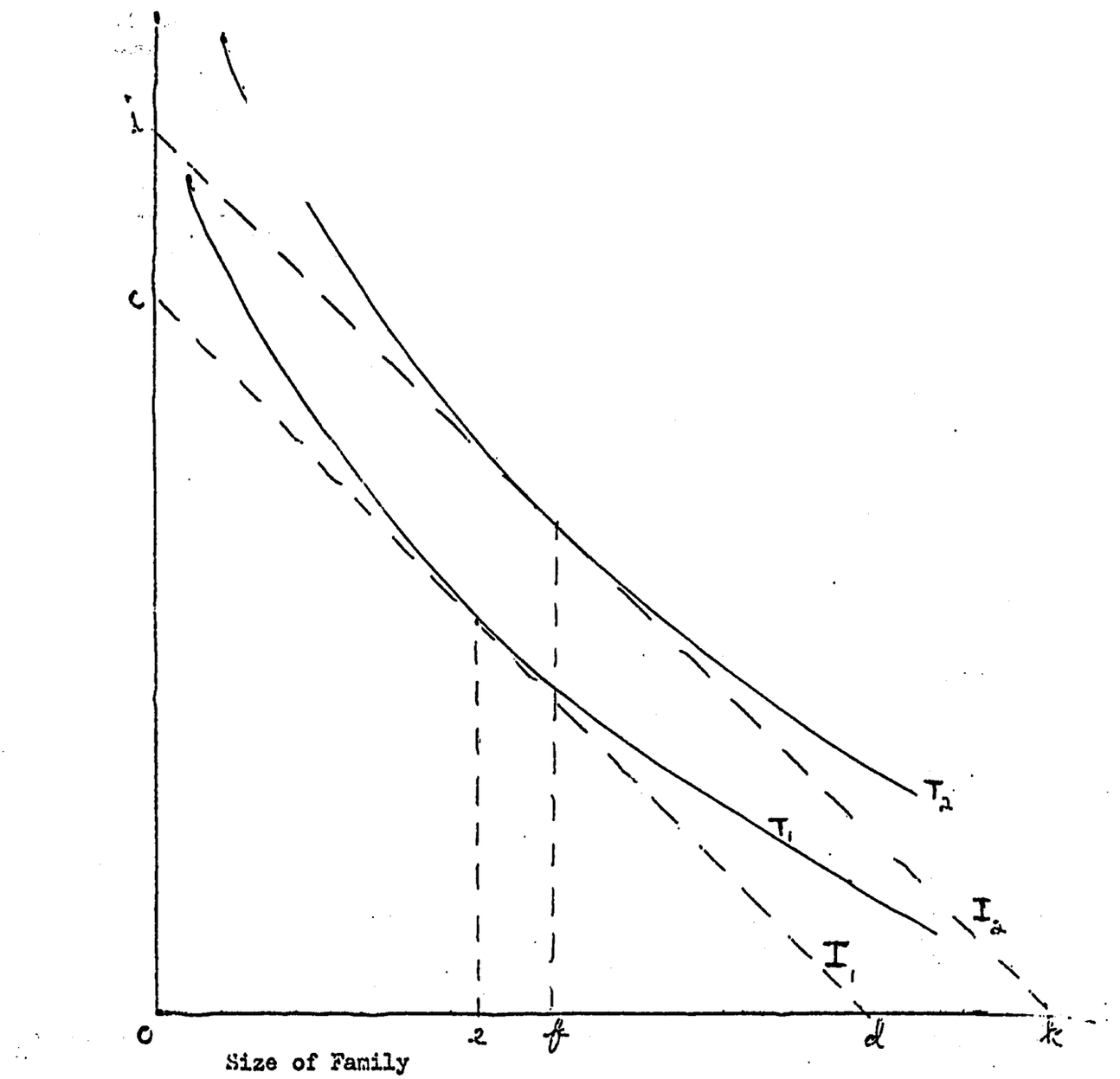
Material Goods
and Services
a
c
T_2
T_1
I_2
I_1
0
e
f
d
k
Size of Family

FIGURE III

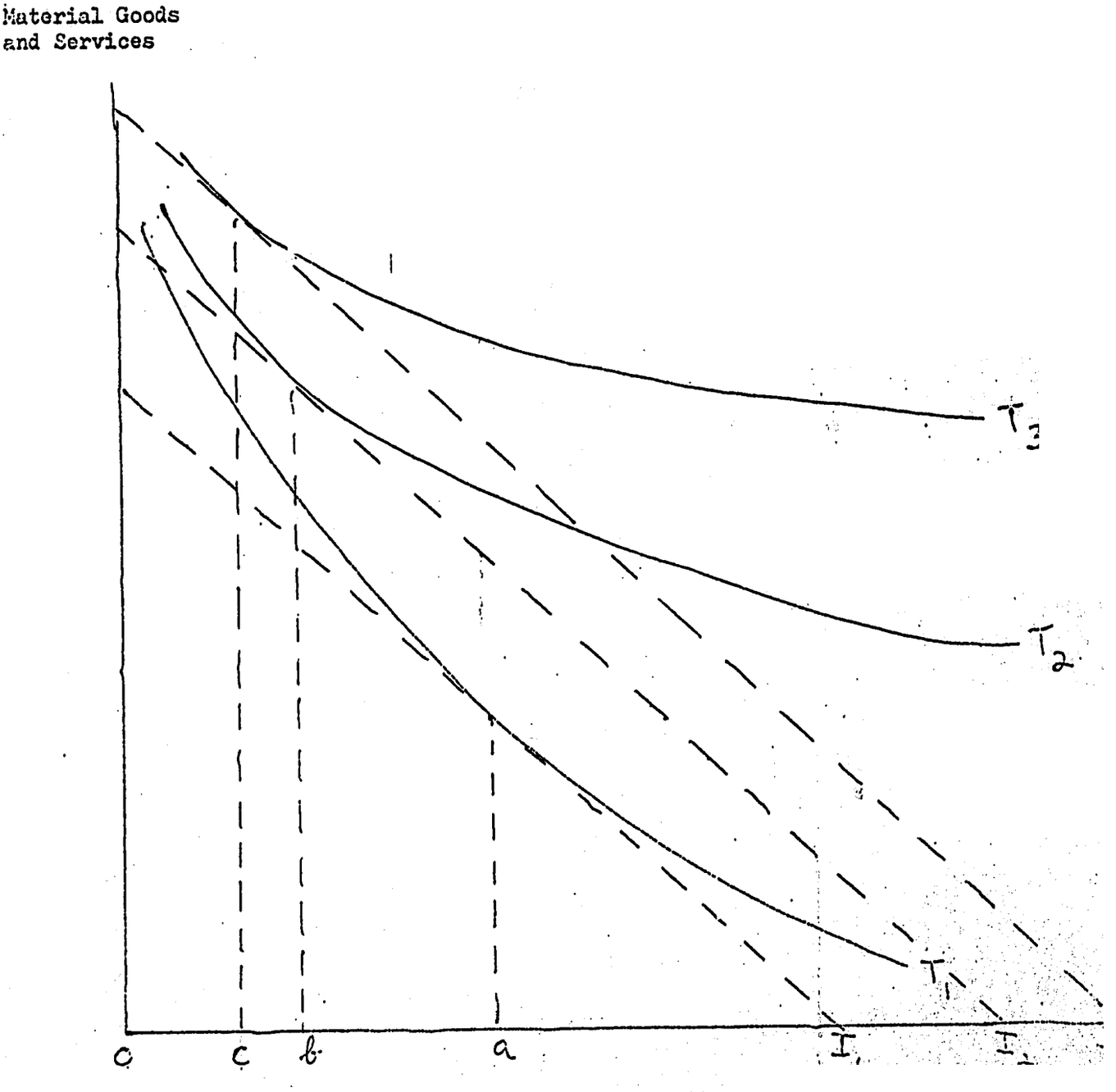

FIGURE IV