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OLD-AGE PENSIONS AND HUMAN FERTILITY IN RURAL AREAS OF DEVELOPING COUNTRIES*

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In many developing countries, older persons are dependent on their children for support. As a consequence, the penalty for not having a surviving child, and in many instances a surviving son, when one is no longer able to support oneself is severe. These observations have resulted in suggestions that the introduction of other mechanisms for providing support to the dependent elderly such as social insurance, viable savings and land markets, and private pensions would reduce the value placed on children and lead to a reduction in the population growth rate.

The objective of the research project "Old-Age Pensions and Human Fertility in Rural Areas of Developing Countries" is to analyze the role of the old age security motive in the fertility decision and to evaluate the potential influence of introducing social insurance programs in rural areas on fertility and population growth. At present, references to the "old age security" motive for fertility in developing countries are common, but evidence documenting the importance of this motive in the fertility decision is limited. Attitudinal surveys do indicate that parents expect to be supported by their children when they are too old to work and, as a general rule, direct observation in developing countries indicates that the majority of older parents are dependent on their children for support. However, these studies do not provide much evidence regarding the importance of the old age security motive in the fertility decision nor do they indicate the extent to which a social insurance system or some alternative system for providing support to the dependent elderly could be expected to influence fertility.

The purposes of this report are (1) to review the cultural, social, and economic institutions and other circumstances which condition the actions of

individuals and families including childbearing, (2) to present an analytical framework both for investigating the role of the "old age security" motive in fertility and related decisions (such as household formation) and for assessing the potential influences, both direct and indirect, of introducing a social security system on fertility, and (3) to outline the implications of the analytical framework which may be tested with household survey data and specifically the panel data from rural India. In all three sections, the importance of understanding the context in which the fertility and related decisions are made is emphasized.

In the first section, we give special attention to the institutions and other circumstances which determine the size and structure of households and to the role which the household structure plays in such decisions as fertility, allocation of resources, and household formation. In the second section, we accept the household as a significant institutional unit but argue that the actions of individuals within the household may be more fruitfully examined if we acknowledge that different types of decisions are made by distinctly different groups of individuals. For example, we give the individual female considerable choice with regard to her childbearing decision, but we give the household head responsibility for the allocation of time and goods to market and household activities and for savings and investment decisions. In the third section, we indicate the possibility of learning more about fertility and related family decisions from individual household serveys, and specifically the three year panel survey of rural India.

A major objective of the research project is to employ data from two distinct cultural settings, rural India[1] and Malaysia,[2] in order to test and refine the analytical framework which we are developing. At this time we have cleaned, merged, and reorganized the Indian data so that it is fully operational. We anticipate that the final tape of the Malaysian data which

we plan to utilize will soon become available (probably in early May, 1980). The Malaysian data are somewhat more comprehensive than the Indian data and will allow us to test specific implications of the analytical framework which cannot be tested with the Indian data.

Although these data sets are not without their limitations, by general agreement they are among the very best sources of data on rural areas of developing countries capable of testing as complex a modelling framework as ours.[3] While individually neither one of these data sets is sufficiently broad to test more than a small portion of that framework, because of their complementarity, collectively they should allow almost all of the important hypothesized relationships to be tested with data drawn from large random samples.

Our presentation begins in Section I with our review of the relevant literature on household structure, old-age security, and fertility. This section is divided into several subsections.

Section II presents our modelling framework. In contrast to much of the recent economic modelling of such relationships which tends to emphasize the simultaneity of static and dynamic resource allocation decisions including fertility, our approach is modular, thereby allowing for the interdependencies among these various decisions but more realistically recognizing both that their timing is far from simultaneous and that the influences exerted on such decisions by different individuals or groups thereof within the household unit vary quite significantly from one decision to the other. Specifically, the modelling framework is divided into five distinct stages, each dealing with a different decision or set of decisions. Stage I deals with fertility. Stage II develops an overlapping generation model with four generations for analyzing how living arrangements or household structures are determined. Given the structure of the household, stages III and IV determine the optimal allocation of the household's resources, including those of time, statically and dynamically. Stage V deals with

the probability of marriage, and its price. Finally in Section III we indicate which relationships in our multistage analytical framework can be tested with the Indian data and outline the procedures indicating how they can be tested. The section is concluded with some brief hints of how other relationships can be tested with the Malaysian data.

It is to be emphasized that this report is merely a progress report. At present we are only a little over half-way through our review of the rather extensive anthropological and sociological literature relevant to the issues under investigation in this project; this review shall continue and may well call to our attention the need to revise or further generalize the modelling framework outlined in this report. An important purpose of the present report, moreover, is to provoke criticism and to generate additional suggestions from the readers of this report as to additional literature to be reviewed, additional issues to be considered, and other external conditions which may affect the various decisions encompassed by our framework. Furthermore, preliminary empirical testing with the Indian data may suggest the need for other modifications so as to be more consistent with the reality of rural India and perhaps other developing countries.

The primary purpose of both this report and the research project from which it emerges is to provide an operational framework linking the various types of behavior--economic, demographic, and social--as we deem appropriate for analyzing the role of the old-age security motive in fertility behavior in the long run. Once that framework is established and tested, appropriate implications for both theory and policy will be derived.

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[1]For India, the data utilized are the three-year panel survey of 4118 rural households known as "The Additional Rural Income Survey" collected by the National Council of Applied Economic Research under AID support.

[2]For Malaysia, the data are the multi-year panel surveys that make up the "Malaysian Family Survey" developed jointly by a RAND team including William Butz and Julie DaVanzo and by Survey Research Malaysia under the auspices of AID.

[3]Note for example the high hopes for this data expressed by Birdsall, et al. (1979).

I. Old-Age Security, Household Structure and Fertility: Some Implications for Modelling Drawn from the Literature.

This portion of the report is divided into the following sections: Section A, dealing with findings concerning the importance of the old-age security motive for fertility; Section B, concerning the choice of the appropriate decision-making unit, namely the residential household; Section C, which treats the variations in household types over time and space; Section D, dealing with the determinants of household affiliation and partition decisions; Section E, concerning the allocation of the household's resources; Section F, concerning marriage; and finally Section G, focussing on fertility decisions and infant mortality and the interrelationships between the

A. The Importance of the Old-Age Security Motive in Fertility Behavior.

Although until relatively recently very few economists (e.g., Leibenstein (1957, 1978), Boserup (1965), Clark (1967), Neher (1971)) have given much attention either in their theoretical models or empirical studies to the old-age security motive for fertility, it has certainly not gone unnoticed among rural sociologists, anthropologists, and historians who have done much interviewing in developing countries and especially in the rural areas thereof.

Children become important sources of old-age security primarily because of the absence of alternative vehicles for obtaining old-age security. Capital markets are often so limited or nonexistent that there are virtually no assets that one can accumulate and then sell-off to live off of during one's old-age. Even if one could do so, the uncertainties about the terms on which one could sell such assets may be sufficiently large to discourage such a practice. Many assets that are available in rural areas are incapable of being accumulated beyond low levels, e.g., livestock, foodstuffs. The property rights of other relevant assets, like land, are frequently restricted so that such assets can neither be bought or sold. Indeed, rural land is held communally in many societies, and even where it is not, the value of private accumulations may be rendered highly insecure for a number of different reasons such as the lack of law and order, the

threat of invasions by landless squatters, uncertainties of nature such as floods, volcano erruption, environmental pollution, and droughts that can reduce property values significantly, especially considering the narrowness of such markets in specific rural areas. Moreover, because experience with and intimate knowledge of the land is often essential to making it productive, its value is often considerably less to others than it is to the family that has farmed it for generations. Financial and other more liquid assets are either not widely available in rural areas, of if (like money, for example) they are available, their value is so vulnerable to inflation as to make such accumulations uneconomic. Finally, even if there were means of accumulating and then decumulating assets, dependent old persons would not be able to purchase the goods and services they need in local markets, and hence all the thrift in the world would do them little good (Ben-Porath (1976)). On the other hand, children and grandchildren can produce the required goods and services and, particularly if one trains them to be loyal, can be extremely efficient and reliable sources of such services. This is not to say that asset accumulation is irrelevant; indeed as we shall see, it can be quite relevant in as much as the promise of inheritance of such assets can be an important instrument for inducing the loyalty of one's children (Parry (1979), Smith (1978)). As Kingsley Davis in reviewing the experience in a number of countries put it: "Young adults can thus provide (through children) security for their old age even when few other means are available, and they are encouraged to do so by their elders."

Naturally, such conditions are not universal. Some societies may have a well-established communal mechanism for caring for their old and disabled citizens. Extra familial private philanthropy or official government programs could be highly developed in certain societies. Indeed, social security and old-age pension systems have now been adopted throughout much of the developed world, and at the same time have come significant declines in fertility. Old-age pension systems are, however, still a rarity in rural areas of developing countries.

In the following paragraphs we demonstrate the apparent pervasiveness of the importance of the old-age security motive in rural areas of developing countries with some examples chosen primarily to show that the motive is not limited to narrow geographic areas or special institutional circumstances.

Among societies where interviews have turned up the importance of children as sources of old-age security are:

(1) Java (Nag, White, and Peet (1978))

"It seems that, to a very great extent, parents rely on their own (including adopted) offspring, etc., at least for their immediate, day-to-day support. A couple with few or no living children is often eager to adopt one or more, preferably from among the children of a sibling or other close relative, precisely to ensure this kind of support." (p. 299)

(2) Nepal (Nag, White, and Peet (1978))

"... this indicates that here, too, most elderly persons depend on their children, children's spouses, or grandchildren." (p. 299)

(3) Solomon Islands (Keesing (1970))

(4) Japan (Smith (1977))

(5) Mexico (Ryder (1976), Van Keep and Rice-Wray (1975), Gillaspy and Nugent (1979))

Note for example in the Van Keep and Rice-Wray KAP study that almost 40 percent of the urban women interviewed agreed that "having many children is a guarantee of being well-looked after when one is old."

(6) Botswana (Mueller (1979))

The desire for large numbers of children on the part of poor rural women probably is motivated by this striving for security rather than by the value of child labor. (p. 30)

(7) Kgatla, South Africa (Nag (1962))

Among the principle factors behind the high level of fertility was the fact that "parents rely upon their children for support in their old age." (p. 29)

(8) Ceylon (Nag (1962))

"Old people depend on their sons for economic security. Often aged parents especially when widowed, live with the eldest son." (p. 45)

(9) India (Nag (1962), Babu (1979), Vatuk (1980))

We note that from the rural survey utilized in this study that more females indicated that children were desired for their old-age security benefits than for any other reason. Cassen (1978), although stressing the sensitivity of rate-of-return-to-children calculations to rather arbitrary assumptions about cost, age, and value of first productive work, etc., points out that the rationality of investments in children hinges principally on (1) the fact that they are a form of forced savings, which is important when incomes are as low as they are throughout India, and (2) their reliability for old age relative to other forms of investments or insurance.

This brief list of societies in which the old-age security motive has been alleged to be of considerable importance in fertility behavior is certainly incomplete. Undoubtedly, it can easily be supplemented.

It should also be pointed out that other factors such as "survival", "viability", the desire for survival of the family line, prestige, etc., that have been identified in other field studies as motives for fertility may simply be proxies or disguises for the old-age security motive. Hence, the relevance and importance of the motive may well be widespread.

One of the barriers to theoretical and empirical analysis of the security motive has been the difficulty of separating out the interdependent determinants of fertility and other closely related forms of behavior, and to distinguish causes from effects given the interdependencies between the various motives, circumstances, and responses. For this reason any adequate analysis must take into account the relevant institutional circumstances, the context within which fertility and other decisions are made (Carter and Merrill (1979), Birdsall, et al. (1979)).

B. The Choice of the Appropriate Decision-Making Unit.

Economic studies have often taken the decision-making unit for granted, merely adopting that unit, be it the individual, the household head, the firm,

which is analytically or statistically convenient. Once the decision is made, the tendency in the literature toward more sophisticated general equilibrium models (as opposed to the earlier partial equilibrium models) has brought with it the implicit assumption that the unit of analysis, i.e., the decision-making unit, is common to all the decisions made simultaneously. In our opinion, in the context of demographic behavior and household decisions, this assumption is unrealistic, quite possibly invalidating the conclusions derived from such studies.

Specifically, on the basis of our reading of the anthropological literature, we consider it more plausible to argue that different decisions, though interdependent, may be made by different individuals or groups within the household.

We adopt the household as the basic unit of analysis. Among anthropologists there is admittedly some controversy on the issue. For example, some (Kessinger (1978)) argue that common property as opposed to common residence is a more appropriate unit of analysis, while others argue that a higher level, e.g., the clan, tribe, or set of persons with common kinship relations, is the appropriate unit of analysis.

Although there are merits to these alternative perspectives, we find compelling the arguments that anthropologists have made for using the residential household as the basic unit of analysis.

First, although broader kinship relations can be important in various circumstances, as Shah (1974) has pointed out, interhousehold relationships cannot be properly understood unless one starts with a satisfactory analysis of intrahousehold relationships and the way in which the household functions.

Second, as Ben-Porath (1977) has emphasized the importance of transactions costs in poor rural areas of developing countries mitigates against transactions outside of the household. Overall, although there may be more rituals and other exchanges among kinfolk beyond the household, much more is done (involving more transactions) within the residential household relative to beyond the household than in more developed societies.

Third, the distinction between the residential unit and property-holding unit may not be very important. Numerous studies have shown that the correspondence is in fact quite close, and in those relatively few instances where groups have separate residences but common property, such arrangements may be simply temporary, representing an interim transition point on the way to complete partition of both property and residence (Parry (1979)). Given that the scope of interrelations and coordination among members of a common residence is greater than that of a common property group, for any analysis of fertility behavior, such as ours, the appropriate choice between them would seem most certainly to be the household unit.

As Carter and Merrill (1979), Nag (1962), Shah (1974), and others point out, however, it would seem important to allow for different individuals or subunits of the household (especially in the case of "extended" family households) to play different roles in different decisions. Clearly, different subgroups are relevant in deciding whether or not to live in a joint family or to separate; the head of the household may be the relevant decision maker for many decisions, especially those involving the allocation of resources; wives are of especial importance as far as fertility decisions are concerned. The relative importance of different individuals in some forms of behavior may vary from society to society, but within any society certain norms can generally be detected (Nag (1962)).

C. Variations in Household Types Over Time and Space.

Once one adopts the household as the basic unit of analysis, one has to come to grips with the diversity of household types that characterize rural areas of developing countries. Households vary widely in size and structure in most rural areas. Not only are there marked differences in size and structure from one household to another, but very conceivably there may be systematic changes in them over time, which may be intimately related to the fertility and other decisions made within the household (Carter and Merrill (1979), Birdsall, et al. (1979)).

Of particular interest and importance for fertility behavior are two

complementary hypotheses: first, the hypothesis of a secular trend in household types toward the nuclear type that dominates in "western" developed countries; and second, the hypothesis that the institution of the extended family contributes to the high fertility rates prevailing in most rural areas of developing countries. For example, Davis (1955) argues that extended families would favor high fertility rates by lowering the costs of bearing and raising children, reducing the age at marriage by removing the need to accumulate savings for household formation, and by increasing the incentive for a wife to have children early in marriage to induce her husband to split off from the parental household thereby protecting her from her inlaws. See also Lorimer (1954), Davis and Blake (1956).

The transition from "traditional" extended family households to nuclear ones would then be expected to lower fertility rates gradually over time. Despite their seeming plausibility, however, both component hypotheseses are open to challenge.

First, there does not seem to be any compelling evidence that there has been a general trend toward nuclear households. Indeed, if anything the evidence seems to be that no discernible trends are in evidence, despite substantial economic and social change. First, historical studies for developed countries for example by Laslett (1972), Goody (1972), Smith (1978), Goody, Thirsk, and Thompson (1976) have shown little evidence that the developed countries have ever been dominated by anything but nuclear households. Second, in so far as the limited data available permit, historical studies for developing countries, especially those of Kessinger (1974), Orenstein (1961), Gore (1968), Karve (1963), Avalaskar (1966) for India where secular decline of the extended family hypothesis had been earlier put forward by Bailey (1957) and Epstein (1962), reveal little trend, the nuclear family always having been dominant in terms of numbers of families. Such studies have been supplemented by historical studies in other countries, e.g., Cohen (1976) for China, Little and Price (1974) for Africa, and Fukutaki (1967) and Smith (1977) for Japan, and by the findings (again for India) by Rao (1968), Gore (1968),

Kolenda (1967, 1968) suggesting that urbanization, industrialization and other modernity factors do not reduce the incidence of "extended" or "joint" families. On closer scrutiny it turns out that the evidence suggesting that extended households in developing countries had been more common in earlier times is based primarily on legend, myth, and social and religious norms which may not necessarily have been based on historical experience (Shah (1974)).

The second hypothesis, that of higher fertility in extended family households than in nuclear households is also open to challenge. Stykos (1958), Burch and Gendell (1972), Carter and Merrill (1979) call attention to some weaknesses in the a priori arguments of Davis and others as to the pro-fertility bias of the extended household. While the possibility of living in the extended family may make it easier as far as the couple is concerned to marry and raise children, the joint household as a whole has to face up to the costs of financing marriages (which include both brideprice or dowry payments and the costs of often elaborate wedding feasts and can thus be major investments as far as the household is concerned) and of feeding and raising the children in that household. It should not be surprising, therefore, to find that households make such decisions deliberately and rationally and exercise some influence on the fertility decisions of couples living within them.

Second, the historical studies in Europe and elsewhere that have shown the long-run constancy of household types have also revealed cyclical movements in household size, hence demonstrating that both nuclear and joint households can be consistent with either high or low fertility (Laslett, ed. (1972), Tilly (1978)). The historical cycling evidence has been supplemented by the cross-sectional observations by Nag (1962), Goode (1963), suggesting that both nuclear and joint households in different environments vary considerably as far as fertility is concerned. This evidence greatly weakens the case that there is any systematic difference between nuclear and joint families especially in the extent to which they are rational.

Third, the hypothesis has been tested quite extensively in India, the context in which it has been most commonly applied, with at best ambiguous results. Indeed, the majority of the studies, and especially of the more well-designed ones such as Nag (1967), Pakrasi and Malaker (1967), Bebarta (1977) and Shah (1974), yield reverse findings suggesting that fertility rates tend to be lower for women living in joint or extended households than in nuclear ones. The results for other countries such as Freedman, Takeshita, and Sun (1964), and Liu (1967) for Taiwan are more mixed. The ambiguity of the results seems to arise both from the rather arbitrary distinctions that have frequently been drawn between those households that have been classified as "nuclear" and those that are "joint" or "extended" (Shah (1974)) and from shortcomings of the data and research designs employed in these studies (Bebarta (1977), Shah (1974), Burch and Gendell (1972)). As Burch and Gendell (1972) emphasize, since the household structure tends to vary with the life cycle of the family, it would seem important to distinguish the character of the household of current residence of the women from that of residence in childhood, upon marriage and all during her fertile years. Most importantly, as Shah (1974), Burch and Gendell (1972), Parry (1979), and Carter and Merrill (1979) have all persuasively argued, there may be a self-selectivity bias problem and also interdependencies between fertility and household structure suggesting the need for a more complex analytical model and testing procedure in order to separate out other differences such as wealth, occupation, education, and religion, between nuclear and extended households and to determine the extent to which household structure causes fertility rather than vice-versa. Parry (1979), in particular, has stressed the possibility that differences in fertility behavior among the wives of male siblings living within a joint household may be a determinant of household partition. Shah (1974), Vatuk (1980), Keesing (1970), Bebarta (1974), and Smith (1977)) stress the relevance of the joint household as far as old-age security is concerned.

The lesson to be drawn from this literature is unmistakable. For any

satisfactory treatment of the relation between old-age security and fertility, one must not only take household structure and changes therein into consideration, but also account for the interdependencies among wealth, income, household composition, inheritance rules, the shares of household subunits in full income and expenditures, marriage costs, mortality, and of course both household structure and fertility.

D. Determination of Household Affiliation and Formation/Partition Decisions.

The fact that households go through a life cycle with respect to size and structure has been acknowledged in the previous section. Indeed, Fortes (1949), Goody (1958, 1972) and others have suggested that this natural life cycle of the household is its most important feature, suggesting that the position in the life cycle is the most important and perhaps even sole determinant of household size and structure.

More detailed investigations, e.g., by Kolenda (1968), Shah (1974) and others, however, tend to illuminate the rather wide variations that exist in household structure even after taking position in the life cycle into consideration. Although most households will follow the life cycle, in general, there are certainly variations in degree and timing that would not appear random (Parry (1979)). Thus, allowing for differences in institutional conditions, region, status or caste, etc., still leaves one with a great deal of variation in household structure to be explained, and furthermore, begs the question of why such differences should exist. (Could it not be that the institutional, caste and region differences exist as rational and systematic responses to other differences, such as in mortality and wealth, that conceivably could be related to old-age security, fertility, and household structure?)

At this point, then, it becomes important to give credence to the view that household composition may be the outcome of the rational calculation by the various actual or potential members of a household separately or in subunits as to whether or not to live together. Much of the anthropological literature quite naturally

focusses on the personalities involved, and in the Indian context pays considerable attention to the rivalries and personal conflicts that arise between the adult female members in joint families. This rather traditional approach, therefore, tends to attribute partition decisions within joint households to such conflicts which would seem to be both random in occurrence and inevitable.

Recently, however, an important minority of anthropologists, e.g., Shah (1974), Kolenda (1968), Parry (1979), Carter and Merrill (1979), have become increasingly skeptical of this view, finding variables that seem systematically related to the probability that these random conflicts will result in partition.

> Although personalities undoubtedly come into it, such decisions are not, I suggest, a purely random outcome of individual whims or of a man's sudden realization that he can no longer face the prospect of living at such close quarters with his brothers. The crux of the case I shall argue below is that these individual decisions conform to a pattern which can only be understood in the light of a set of material constraints imposed by the employment and inheritance prospects of men, and by marriage strategies of fathers vis-a-vis their children. (Parry (1979), p. 179)

Household affiliation and compositon are in this light the outcome of individual or group strategies of how to maximize one's situation given the relevant resource and other constraints. The outcome is the net resultant of centrifugal and centripetal forces. What forces can be identified? Most observers have found that the factors involved and their relative importance tend to vary with the type of relation--the father-son or intergenerational relations generally being stronger and subject to somewhat different pulls and pushes between siblings.

Certainly all such relations are subject to societal norms which can be deviated from only when one is willing to pay a price in terms of moral and other sanctions. Both the norms themselves and the sanctions against their violation vary from society to society. In India, for example, the norms and the moral sanctions on those who sever familial relationships prematurely (as for example the partition of a household by a son prior to the death of his father) are considerably stronger in the case of father-son relations than in other cases.

As Parry 1979 points out, it is the combination of these societal norms and environmental constraints which conditions household affiliation and hence formation and partition decisions.

> In any single instance partition takes place because individuals decide that it should and this decision is made within the context of certain demographic, economic, and moral constraints. It is these constraints on choice which generate regularity or frequency in empirical form. (Parry (1979), p. 155)

> ... individual and group self-interest (i.e., what was economically rational) varied widely. As a result, the economic value to an individual living within a joint family or of making use of the authority structure and role relationships of a joint family...also varied widely. (Owens (1971), p. 223)

Chief among the forces of attraction is almost certainly the security motive. Large, complex families provide a mechanism for pooling risks. The advantages of joint or extended households need not be confined to the security motive and the risk-sharing advantages of cohesion. Nevertheless, the relevance and importance of the old-age security motive is a major consideration in favor of cohesion with respect to fathers and sons and their respective wives and children (Shah (1974), p. 50). Even those observers, e.g., (Cassen (1978)), who have failed to see household affiliation as a rational decision, and those who have failed to appreciate the other advantages of the joint household, such as economies of scale and specialization, have not failed to appreciate the risk-sharing advantages of the large extended household. For example as Cassen (1978, p. 76), a strong critic of the system, expressed it:

> In a society lacking in communal supportiveness, where the powerful use and perpetuate their advantages in every conceivable way, the family becomes for most people the only source of security. It is an inefficient and in some ways a cruel one; it will continue so until an alternative appears.

The old-age security benefit to the old of living in joint family arrangements accrues, of course, only if one's children are loyal and provide intrafamilial transfers. Loyalty, however, is something that parents can at least partially inculcate in their children, and numerous field studies have noted the many sometimes subtle ways in which children are trained to be loyal. Normally, the

mother plays an important role in such training, and this may not be entirely accidental considering that in many societies wives are younger than their husbands, making it likely that they will become widows, and hence a high proportion of old-age dependents are, in fact, widowed mothers.

The reasons why joint family living arrangements have advantages as far as old-age security is concerned are several. Certainly the aforementioned higher transactions of extrahousehold activities relative to intrahousehold ones and the absence of markets for the goods and services that old-age dependents need in rural areas of developing countries have a great deal to do with it. Also, there are the advantages of scale and division of labor given the specific factor proportions of supplying those goods and services. A rather neglected advantage is the fact that living in an extended family with one's parents may help inculcate loyalty, providing an important example or demonstration case to one's children of how they, too, should take care of their parents in their old age.

There are, of course, ways in which such goods and services can be provided to old-age dependents without joint living arrangements, such as when the old-age dependents live next door and food, clothing, and the like can be brought in. This goes back to the choice of the decision-making and statistical unit, discussed in Section B above, the balance of pros and cons seeming to favor the household as the most appropriate unit in most but not all circumstances. Although the living-next-door arrangement may be a close substitute for joint living arrangements, it is certainly not a perfect substitute, and separate living arrangements may considerably reduce the coordination of decision making and resource allocation between the households, even though they are within the same family, and in close proximity to one another.

The recent studies of Bebarta (1977), Shah (1974), and especially Parry (1979) are the source of many additional hypotheses about factors affecting the decision to live together or apart.

(1) Inheritance and Wealth.

The prospect of inheritance is certainly an important instrument that older persons have to induce flows of desired goods and services from their potential heirs. In most societies inheritance generally goes from fathers to sons or mothers to daughters in matriarchal societies. In some societies, such as those in parts of Africa, inheritance goes from brother to brother. Not suprisingly joint households among siblings are more common in the latter societies whereas joint households among parents and their children are more common in countries where the former types of inheritance rules dominate (Goody (1972)). In most societies where inheritance goes from father to son, land and other accumulated endowments are not transferred until death of at least the male parent and sometimes also the death of the female parent. The threat of non-bequeathal is certainly an important tool in the hands and minds of parents to instill loyalty on the part of their children.

Its effectiveness can be constrained by certain institutional rules and constraints such as those of primogeniture or equal division rules (which may have been established to control fratricidal murders and disruptive fighting). Its effectiveness can also be reduced by the absence of competition, as when there is only one potential heir. Parents can make this tool more effective by having several children or indeed several male children in patriarchal societies. Notably, however, the rules tend to be defined to fit the circumstances and there is often considerable deviation of actual practice from official rules. (Parry (1979) points out, e.g., that the Indian government's effort to guarantee equal inheritance shares to female children as to male children is disregarded in rural areas.) The effectiveness of the inheritance instrument is strengthened if the parents can wait until the last possible moment in naming their heir.. When forced to make such a decision in advance of death, other things being equal, there may be advantages to naming the youngest son as the heir since the youngest son offers the greatest security by his higher probability of

longevity; and by holding off the decision until the youngest son comes of age and is fully productive, the parent maximizes the contributions that he (she) is in the meantime able to extract from the older sons as earners and providers to the joint family by holding onto them as long as possible during thier prime working years.

Inheritance, of course, is ineffective if there is nothing to inherit. Hence, the extent to which parents are likely to be able to hold on to their children and indeed their loyalty by the bequeathal promise will be positively related to their wealth.

(2) Other Advantages of Wealth and Land.

Aside from its relation to inheritance and hence its ability to induce loyalty in the form of intrahousehold intergenerational transfers, the quantity and quality of land and other forms of wealth can also have other cohesive influences. Children and siblings of working age may have outside employment opportunities. Their willingness to remain in the joint household under the direction of the household head will be affected by the differential benefits relative to costs of remaining in the household or of moving out to take advantage of those outside employment opportunities. While there may be circumstances wherein one can work elsewhere than on the family farm and yet remain in the household, there are certainly limits to such possibilities and hence often a decision to work elsewhere is accompanied by a decision to move out. In such circumstances, given the available opportunities for off-farm employment, the more land available within the household the higher will be the marginal and average productivity of on-farm labor and hence the more likely the extra worker can be induced to stay on the farm and in the joint household (or if there are no male children the more likely it is that husbands can be induced to marry-in with their daughters or that sons can be adopted. Fuller (1976), Shah (1974), and Parry (1979), among others, provide rather convincing empirical evidence supporting the hypothesis that the propensity to live

in a joint family household is positively related to wealth. Indeed, Shah (1974) goes on to suggest two additional reasons for the cohesive influence of wealth: (1) that wealth or income is a cure for the intrafilial feuds that develop, especially among wives in the joint household, and (2) that wealth and income increase survival rates, thereby making old-age dependency more relevant and important for wealthier households.

(3) Migration and Occupation.

The aforementioned influences apply primarily to farmers and to on-farm activities which are of course the primary sources of employment in rural areas. Increasingly, however, industries are being established in or near rural areas, transportation and communications are improving, and people are migrating from the rural areas to cities and towns. The effects of such changes on household structure are more difficult to predict.

The advantages of land wealth, inheritance, etc., may be less to those who will take up non-agricultural occupations. Hence, these influences may be expected to lead to fragmentation of the joint or extended household. As Parry (1979), Kolenda (1968), Rao (1968), Owens (1971), and Vatuk (1972) have emphasized, however, such expectations have not always been fulfilled suggesting the presence of some offsetting influences.

Even if a son or brother should find it advantageous to go elsewhere, e.g., to a city or town, employment, the higher cost of living in that location may induce the migrant to keep his wife and children in the joint household back on the farm. The cash remmittances that he is able to contribute are also likely to be very desirable as far as the other members of the extended household are concerned. Hence, out-migration and occupational change may actually be conducive to joint family living arrangements (Parry (1979)).

Disputes in such circumstances are more likely to arise, and partition of the household to take place <u>after</u> an out-migrant, who has contributed substantially to the household's budget, returns and feels that he is not provided with his

fair share of the household's resources.

Because of the differences in the comparative advantage of household members of different age and sex performing the various household tasks, individuals are not likely to break off from the joint household. Generally only married couples, or couples plus children, will break off (Parry (1979)). This factor is closely related to the viability or essentiality characteristic that anthropologists have commonly referred to. As a minimum requirement, a household must have both male and female members, given the traditional division of labor that is established between the sexes which will be discussed in the next section.

(4) Fertility Differentials Among Couples Living Within the Joint Household.

If all male members of the household provide an equal common budget of the joint household, the propensity to partition will be greater, the greater is the differential in fertility between the wives of the married males. To avoid friction, fertility differentials would have to be compensated for by differential contributions to the household budget. Note, however, that children and wives can provide at least part of these differential contributions.

The timing of marriages can also be a factor in partition. In India, for example, where marriage costs are of major importance in the overall household budget, and a brother has no responsibility for financing the marriage of his brother's daughter after partition, partition is likely to take place prior to the marriage of the children of siblings.

Given the interest of wives in providing for their old-age security via offspring and also for wanting to get out from under the domination of her in-laws with whom she lives with initially (which is an especially understandable motive in the Indian context), wives may feel that having children early in marriage would be beneficial for them in part because it is likely to induce partition of the joint household. On the other hand, once a wife becomes the mother-in-law in the joint family household, and assuming that she already has had male children, it is in her interest to stop having children in order to induce her sons to

remain in the joint household. This economic explanation would seem to explain the otherwise paradoxical findings of Bebarta (1977) that women in joint households have children earlier than other women but also stop having them earlier, making it possible for their completed fertility to be lower than that of women living in nuclear households.

While anthropologists have put forward these and other interesting hypotheses that have implications of potential importance for both theory and policy with regard to fertility, their reliance on essentially inductive techniques wherein their data generates their hypotheses implies that these hypotheses have not yet been tested in any meaningful sense.

E. The Allocation of Household Resources and the Division of Labor.

Since for the most part there is coincidence between the property-holding group and the residential group, the household's resources are generally utilized collectively and allocated by the household head whose responsibility it is to resolve disputes about the fairness of resource allocation within the household. Genreally, household heads allocate resources in what would seem a "rational" or "efficient" manner (Parry (1979); Carter and Merrill (1979)).

Given the variety of tasks that have to be performed within a rural household, only a small proportion of which are typically marketed, it is not surprising that there is substantial room for variations in comparative advantage among the different members of the household and that a division of labor and degree of specialization among tasks is arrived at. Almost all anthropological studies provide at least qualitative evidence of the marked extent to which there is division of labor especially between sexes. Recently, the traditional types of studies of anthropologists have been supplemented by those of others seeking to achieve quantification by studying each individual household member's allocation of time across activities. There are, of course, some fundamental problems in arriving at such allocations, and some of those problems are especially important in the

present context. For example, should grandparents be credited with time spent in caring for grandchildren or should grandchildren be credited with time caring for grandparents? The authors of such studies have to resolve such questions and ambiguities in one way or another. Unfortunately, the way in which they have been resolved may not be appropriate for all users of such data.

As a result, comparisons of such data, collected as they inevitably are by different authors, are sometimes problematic, differences in findings being attributable in part to differences in arbitrary assumptions. Nevertheless, the results of such studies can be revealing and certain common patterns emerge despite the somewhat different methods employed by different practitioners.

Even allowing for a considerable margin for error, without exception the time allocation studies we have seen (Dasgupta (1977), Nag, White, and Peet (1978), Shah (1974), Cain (1977), Bond (1971), Mueller (1979), Bieze ( ), Da Vanzo and Lee (1978)) which are drawn from a wide variety of countries demonstrate a high degree of specialization by age and sex. In particular, young girls spend large portions of their time on those activities, such as fetching water, cooking, food preparation, care for the sick and disabled, sewing and repair work, that are in demand by old-age dependents. Young boys spend substantial portions of their time on animal husbandry, gathering firewood, and hunting and fishing; middle-aged men concentrate on the heavy agricultural tasks and on civic responsibilities such as meetings; finally women spend their time on housework, child care, food preparation, and in some cases on marketing and agricultural activities.

If as a result of changes in technology, in market prices, in transport costs, or in institutions (such as the introduction of a social security system of old-age pensions), the household's mix of activities changes, this change in the activity mix can bring about a substantial reallocation of time to activities among members of the common household, and can affect the relative value of having different types of people in the household. In technical terms, the shadow prices of the time of different sex and age groups can be affected, thereby also

affecting the economic value of children and hence desired fertility.

The data on time allocations of old people themselves in rural areas of developing countries is relatively weak. Some of the aforementioned published studies present their statistics on time allocations only for excessively aggregated age groups, such as for all those of 50 years of age or older as in Nag, White, and Peet (1978). Other studies classify people only as to whether or not they are in the labor force utilizing often extremely arbitrary assumptions in making their distinctions. The resulting statistics on labor force participation[4] may, therefore, exaggerate the real differences. Given the variety of productive activities that take place in rural households, only a portion of which enter the labor market, and which are for the most part essential to the household's viability, knowledge of labor force participation, even if correctly and unambiguously measured, is insufficient. (The allocation of time data for the Malaysian panel survey to be used in this study may shed considerable light on how variations in technology, old-age pension system participation, etc., may affect the allocation of time of older males and females in households of different structure.)

The impression one gets from the more qualitative studies of aging in rural areas of developing countries (e.g., Adams (1972), Goody (1976), Vatuk (1975, 1980), Harlan (1964), Raj and Prasad (1971), Mueller (1976)) is that in contrast to their counterparts in urban areas and in more developed countries, older persons generally continue to actively pursue the specialized activities that they perform within the household until very late in their lives, even until severe disability, sickness or death. Little, however, is known as to how productive they are (Ridker (1976)).

There would seem, therefore, considerable potential for a substantial

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[4]E.g., recent ILO study (1971) shows the labor force participation rate of all persons age 65 and over to vary from a low of 26 percent for Iran to a high of 60 percent for Gambia, while that of males to vary from 41 percent for Latin America to 71 percent for Africa.

reallocation of time across activities of older persons, in particular, but indirectly of all members of the household, with the introduction of an old-age pension system. The evidence is quite clear that this has occurred in developed countries (Boskin (1977), Munnell (1974), Pellechio (1979)). But quite conveivably, the honor and prestige associated with continuing productive work and the existing low levels of income, may reduce the "retirement age effect" and other reallocations of time that otherwise might result from the introduction of old-age penisons in such rural areas of developing countries. Furthermore, the negative effect on labor force participation in older persons in developed countries is in part attributable to the specific (high marginal tax rate) features of these programs in such countries, features that may not be applied in the, for the most part, yet-to-be established old-age security programs in rural areas of developing countries. Moreover, even if those features are emulated, given the large distances and communications problems in rural areas of developing countries and also the smaller portion of rural full incomes that originate in the market sector, it is unlikely that disincentive effects on old-age labor could be made effective in such areas.

The dynamic effects of exogenous changes in technology, old-age pensions, etc., such as those on savings, investment allocation, and migration in the rural developing country context, have been less studied, and are probably more difficult to generalize. Many of these influences can affect the level of wealth of the household and hence can affect the household's preference of present versus future, and hence its savings and investment rate. For example, increased commercialization may induce farmers to go into debt lowering their wealth and thereby forcing themselves to save more (partly to pay off their debts). Decreased infant and and child mortality may leave the household with more surviving children of any sex than they had expected, making them feel wealthier, thereby possibly lowering their savings and investment rate. Similarly, the introduction of an old-age pension system may make people feel wealthier and hence lower savings. In the

rural developing country context, however, lower or greater savings may translate into a wide variety of reallocations of the time and other resources of all members of the household.

In all of these reallocation decisions the household head's role is vital. The parallel in these allocation functions between the role of the household head and that of the entrepreneur or manager of the firm is striking indeed. The household head's role is to coordinate and supervise the work of the household, to allocate people and their time to tasks, to either decide or exert leadership in reaching dynamic decisions such as the level of savings and the allocation of investment. The household head's most essential function is to guarantee the basic viability of the household. The work of the household head and of the household as a whole is likely to be most effective when his headship is unchallenged, and because of close family relations in a common residence, there is both good teamwork among household members and a considerable amount of mutual trust, thereby avoiding the need to set up elaborate and costly monitoring activities to detect shirking and self-indulgence by individual household members. With more distant relations or unrelated persons the trust and intimate knowledge of the members of the household team are likely to be weaker and hence less capable of holding together.

The fact that headship is likely to be less open to challenge in father-son relations than in relations among brothers or between uncles and nephews, at least in many societies, makes it likely that father-son joint households will be more successful and be more durable than intragenerational ones or those between uncles and sons (Parry (1979), Carter and Merrill (1979)).

Part of the household head's function is also to train a successor, which cannot easily be accomplished if the head refuses to turn over some of his responsibilities to his successor. Learning-by-doing would seem to contribute greatly to successful headship.

Household heads play important roles in the management of household assets and in determining the rate of accumulation and the allocation of resources. Although the available data is often only anecdotal and qualitative, there is every indication that household heads participate in a major way in education, migration, agricultural investment, and marriage decisions. Since the household head normally has considerable discretion over the allocation of resources, he can exert considerable influence over the composition and structure of the household in as much as he can offer inducements to stay or to leave. Indeed, the household head is also likely to share the power of expulsion over household members, although (according to Parry (1979) and Carter and Merrill (1979)) this power is usually thought to be so strong that it is in fact seldom utilized.

The household head's (and also the non-head husband's) control over fertility and infant mortality of his wife and of his brothers and sons' wives is somewhat more ambiguous, and at best more indirect. Undoubtedly also its effectiveness varies considerably from one society to another, and perhaps even from one head to another. The head is certainly not without instruments. He can usually divorce his wife; he can usually remarry after being a widower or divorced and in some cases can take several wives at once. As for the allocation of resources, the household head may be able to encourage or discourage fertility, but he is usually reluctant to interfere very directly in the fertility decisions of other couples within the household.

There is, of course, much debate about how rational household heads are, and about whether their rationality is better approximated by the profit-maximizing (or cost-minimizing) criterion or by mini-max, maxi-min, or other satisficing strategies. In practice, however, the distinction between these different kinds of rationality is likely to be more one of semantics than of anything else.

Because of the importance of the unchallenged headship position to the integrity and viability of the household, headship succession rules are generally

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clearly established; challenges thereto generally take the form of household partition rather than revolution and overthrow (Carter and Merrill (1979)).

Because marriage and adoption, however, can constitute a dominant part of overall household expenditures, and the presence of male and female succession is of such importance to the short-run as well as long-run viability of the household unit, household heads in many if not most rural societies play a very important role in arranging marriages of daughters and sons--with considerable and sometimes even unlimited discretion over the choice of time, place, and partner in marriage.

The goal of the household head like the entrepreneur in the firm is to achieve static and dynamic efficiency of household production and consumption activities. Overall efficiency is multi-faceted. It requires static efficiency in both production and consumption, but also dynamic efficiency--the dynamic efficiency depending also on viability, trust, teamwork, etc., the preservation of which requires also "fairness" (but certainly not necessarily equality) in allocation and distribution. The efficient solution to household affiliation-composition-partition-formation decisons will be such that the advantages of living together be weighed against the disadvantages (i.e., the advantages of living apart). The advantages include not only those of intergenerational complementarity (and hence security) and the ability to take advantage of economies of specialization, but also economies of scale in both production and consumption. While the sources of economies of scale in production are widely recognized, only recently has the potential importance of economies of scale in consumption been pointed out. In their recent paper on the subject Lazear and Michael (1980) find that economies of scale in consumption can be quite substantial and identify the following sources of these economies: namely "family" goods which are intrahousehold public goods, decreased waste, quantity discounts in purchases, and complementarities in the use of goods over time.

On the other hand, at some point the transactions costs per household member

should start to rise, economies of scale may diminish, crowded conditions, congestion, and headship rivalries arise, and most importantly the diminishing returns to the fixed factor endowments will set in. When the former set of factors dominate, the household head may be successful in maintaining the integrity of the joint household; when the latter circumstances dominate, one may expect that the household head will be unsuccessful and the joint household will partition into two or more units, each with its own household head.

Since entrepreneurial talent on the part of the household heads is certainly not a constant, one may expect that more talented household heads will tend to be heads of larger and more complex households.

F. Marriage.

As has already been pointed out, the bulk of the anthropological evidence on rural areas of developing countries suggests that marriages are more likely to be "arranged" or at least approved than are marriages in more developed countries. (Gore (1968), Jahan (1973), Goode (1963), Dixon (1976)). Marriage also tends to be more essential in such countries, in as much as the long-run viability of households require that it have both male and female members, and preferably those of more than one generation so as to ensure complementarity in production and consumption both statically and dynamically.

The interest of the household head and therefore his involvement in arranging or at least approving marriages may well vary with household structure. In the joint household, the household head generally plays an important role in arranging marriages. The reason why the household head may invest very considerably in search activities is to be sure to obtain a person who is simultaneously a satisfactory, reliable marriage partner for his son or daughter, a productive, hard-working member of the household, a "loyal" person not likely to want to induce partition of the son or daughter from the joint household, thereby lowering the expected value of transfers from children in old age, and also a person who can be trusted and is easy to get along with so as to facilitate good teamwork among

all members of the household.

In those societies where widowed or divorced males can remarry, the household head may enhance his own old-age security in his own marriage by choosing for himself a healthy wife of a younger generation. This mechanism might well lower the male parent's security-induced demand for children. Seldom, however, are wives able to remarry as easily, and still more seldom are wives able to remarry younger males. Hence, old-age dependence is likely to be a particular problem for women (Vatuk (1980)). Their own children are likely to be their best and most reliable source of old-age support.

Since age of marriage is an important determinant of completed fertility, factors that can influence age of marriage can have important consequences for fertility. We have already noted the interdependencies between old-age security considerations and household structure. We have also noted the possibility of different influences on marriage of households of different structure, wealth, and other characteristics. Therefore, it should be obvious that such characteristics and influences can have indirect influences on fertility. The moral of the story is once again that to adequately understand the magnitude and even the direction of these effects, one must have a model capable of sorting out these various interdependencies.

Admittedly, however, there are other influences which may tend to reduce the influence of parents and the household head in arranging or even approving marriages of their children or other relatives in their households. Education, for example, may tend to make children more independent, both by keeping the children away from the household and perhaps by changing their tastes, aspirations, and goals. Also, better communications, commercialization, and other factors that are certainly of growing importance may tend to reduce the role of parents in educating their children about the world, and in making marriage decisions for them (Hull (1978)). It would seem important, therefore, to account for the education of children, non-agricultural employment, and other factors that might

tend to reduce the extent to which marriages are arranged, and which also, of course, are likely to have direct influences on age of marriage and hence on fertility.

G. Fertility and Infant and Child Mortality.

Traditional demographic transition theory has depicted the relation between mortality and fertility to be a close but simple one: namely, it was argued that population growth is attributable to the rather long realization and adjustment lag between decreases in mortality and subsequent decreases in fertility. It does not deny that variations in mortality eventually bring about variations in fertility but suggests that the effect takes a long time to be felt. Traditional theory is, however, both altogether naive and probably wrong as well.

First, recent historical studies have increasingly challenged the view that fertility rate declines lagged substantially behind mortality rate declines in Europe, Japan, and elsewhere, and anthropological studies have tended to reject the notion of a long adjustment lag in contemporary developing countries (Carter and Merrill (1979)). This is not to say that the rapid population growth that has characterized most developing countries in the last two or three decades cannot be attributed at least in part to the decline in mortality rates that these countries have experienced over this period. It should be realized, however, that the sharpness of the decline in mortality rates that developing countries have experienced during these years has been without historical precedent and that fertility rates have been falling quite significantly, at least during the last decade (Birdsall, et al. (1979)).

Second, as mathematical modellers of demographic conditions have pointed out, stability or equilibrium in the relation between mortality and fertility does not necessarily imply a fertility rate consistent with zero population growth (Heer and Smith (1969), Burch (1970)).

Third, the relation between mortality and marital fertility need not be a very direct one for the overall relationship between mortality and fertility to hold.

This is because much of the adjustment to variations in mortality may well take the form of variations in age at marriage, rather than within marriage fertility rates (Wrigley (1978)).

Fourth, changes in mortality can affect several other variables with possible indirect effects on fertility. For example, as Ram and Schultz (1979) have argued, the decline in mortality rates can affect the rate of return to investments in human capital, especially education. This, in turn, can influence household savings, income growth, sex-specific labor force participation, the entire allocation of resources within the household, and in the long run even the structure of the household. Any such changes can influence fertility, and can also have consequences for the direction of the intergenerational transfers within the household (Goode (1963), Caldwell (1976), Aries (1965), Goubert (1970), Laslett (1965), Laslett and Wall (1972), Stone (1977), Thadani (1978)). As Birdsall, et al., emphasize, the overall effect of mortality on fertility can be captured only if one considers both the biological effects (such as the shock and disruption to household activities that sickness and death of one's child may bring about) and the economic effects including both the wealth and relative price effects and both the static and dynamic effects of each. Notably both the relative price and the income or wealth effects of mortality declines may vary significantly from one household to another depending on the size and structure of the household.

Fifth, the direction of causation in the relationship may not be as unidirectional as it had been assumed to be. Much recent work on nutrition and infant mortality has revealed that fertility and birth spacing can have important effects on infant nutrition and hence the probability of survival. As evidence for the hypothesis that infant mortality is at least partially endogenous in rural areas of poor, overpopulated developing countries, Scrimshaw (1978) cites examples of extreme child neglect and even infanticide, the relation of the female work load to infant mortality, the rather marked sex differentials in infant mortality, the positive relation of infant mortality to the accumulated number of preceding

births, and the negative relation to the time elapsed from the immediately preceding birth. Again as the above mentioned new historians of the family point out, expectations with respect to infant mortality can be self-fulfilling and reinforcing. If one expects there to be a good chance that one's child will not survive, one invests little in the child in terms of time and emotional attention; as a result the probability of survival is reduced. Smith (1977) rather convincingly documents with birth registration and census statistics the importance of systematic infanticide over long periods of time historically in rural Japan. Cassen (1978), Parry (1979) and Mitra (1979) suggest that infanticide is not unheard of in contemporary India, especially with respect to female children.

Some of these effects on infant mortality may thus be intended. Others may well be inadvertent. For example, the relationship between close spacing of births and infant mortality, especially of the earlier birth, is attributable to premature weaning of the infant from the mother's breast to make room for the newborn. In the absence of sanitary and nutritionally sound alternatives, there is a relatively high probability that the weaned child will not survive into adulthood (Khan, Hammer, and Lynch (1977), Wray (1971)). For additional evidence of this and other economic and social effects on infant mortality see Heller and Drake (1979)

Interdependence between fertility and infant mortality can also be attributed to the practice of breastfeeding and its effect on postponing ovulation (post partum amenorrhea). The strength of this effect is also affected by health and the nutritional status of the mother (Butz and Habicht (1976)).

Additional evidence for the endogeneity of infant mortality comes from (1) demonstrations that public health improvements such as malaria and other disease eradication programs and programs to supply potable water and provide sewage systems explain only a fraction of the mortality decline in specific countries and (2) studies showing that infant mortality has tended to decline more rapidly in those societies that have achieved reductions in the degree of income

inequality, such as Sri Lanka (Birdsall, et al. (1979)).

With respect to the important issue of the appropriate decision-maker(s) within the household with respect to fertility and infant mortality decisions, as has been mentioned above the role of the household head especially in extended or joint households would seem to be much smaller and more indirect than that in the other decisions which have been reviewed. Most studies (e.g., Dixon (1976), Salaff (1972)) concede to the wife an important, if not dominant, role in fertility behavior, especially in relation to how constrained she is in virtually all other respects. Also on infant mortality, the wife-mother plays a dominant role, although, of course, circumstances can be much affected by the household structure and the static and dynamic allocation of resources. Within the household not only are fertility and mortality variables over which married women are likely to have more control but in view of the likelihood of long widowhood, they also are likely to have the incentive to exercise that control. As Ridker (1976) puts it, "children, especially sons, may appear to be all that will save them from destitution after their husbands are dead...." (Ridker (1976), pp. 9-10)

From the preceding review of the literature we conclude that time and resource allocation including savings and investment allocation decisions of all individuals in the household generally are closely coordinated by the household head. There is a great deal of interdependence among all the decisions made within the household including those of education, migration, marriage, fertility, and infant survival. There is considerable evidence, however, that some of these decisions, especially infant mortality and fertility, are less centrally directed by the household head than others, and more influenced by the wife-mother. This suggests that in modelling these relationships it is important to recognize interdependence between these decisions but not to model them as strictly simultaneously determined as has been the case in several recent economic modelling efforts. Furthermore, it is obvious that many of these relationships may be affected by

the size and structure of the household, which tends to vary quite considerably from one household to another. In the long run, however, the size and structure of the household depends in part on the household's position in the life cycle, but also on its wealth, and the fertility-mortality decisions made by the individual members of the household.

Any satisfactory analysis of the effects on fertility of any fundamental exogenous changes such as those in market prices, technology, and institutions such as inheritance rules or old-age pension systems, must recognize all of these interdependencies in what goes on within the household and the feedbacks back-and-forth from within the household to the household as a whole, which in the long run affect its size and its composition.

II. A Multistage Model Linking Old-Age Security with Household Structure, Resource Allocation, Marriage, and Fertility.

The purpose of this section is to specify a formal model of the relationships between old-age security that includes indirect as well as direct effects and yet which fits the findings reported in the survey presented in the previous section as closely as possible.

The model is one of household decision making and postulates that all household decisions are made rationally, in the sense that they are motivated by a desire to achieve given objectives, subject to environmental, economic, and institutional constraints and a set of initial conditions. The model recognizes that all decisions are made by the household as a whole or by individual members of the household, implying that the decisions may well be affected by the size and structure of the household which apparently varies from one household to another. Because of the finding that different household decisions seem to be made primarily by different individuals in the household, and generally at quite different points in time, the overall model is composed of a series of separate but interdependent models which we refer to as stages. In using the term stages, however, we do not mean to imply that any one stage necessarily comes prior to any other stage in time sequence.

We begin with fertility and infant mortality in Stage I. Household structure and the household affiliation decisions are presented in Stage II. The model also determines the expected value of intergenerational transfers. Stages III and IV are devoted to the static and dynamic aspects of resource allocation within the household. Stage V is concerned with marriage. The interdependencies between the stages are reflected in the fact that decisions made in one stage can affect decisions made at other stages.

A. Stage I: Fertility and Infant Mortality.

In Section I it was found that in contrast to the many other household decisions which are determined, executed, and policed primarily by the household head, fertility and infant mortality decisions are strongly influenced by the wife-mother (of whom there may be several in the case of the joint family house-hold). Moreover, the wife-mother also has a considerably greater role in the execution of such decisions. The degree of the wife-mother's degree of independence and autonomy in such behavior may well vary from culture to culture, and also according to the size and structure of the household.

In any case, it is the relatively greater role of the woman in this behavior that prompts us to treat fertility and infant mortality in a separate stage, rather than lumping them together with all the other static and dynamic resource allocation issues as in several of the better known economic models of fertility behavior (Rosenzweig and Evenson (1977), Becker and Michael (1976)). Moreover, given the closeness of the relationship between fertility and infant mortality that was revealed in our survey as well as in those of others (e.g., Schultz (1976), Butz and Habicht (1976), Birdsall, et al. (1979)), we have deemed it appropriate to put the two together, i.e., determining the number of surviving children.

Following Heckman (1976) we postulate utility of the wife in any period to be a function of her consumption of goods and services, C, her leisure, L, the latter being weighted by her human capital, H, in that same period, and the number of surviving male and female children she has, P^{1m} and P^{1f}, respectively.

$$(1) \quad U_t = U(C_t^w, L_t^w H_t^w, P^{1m}, P^{1f}) \quad \frac{\partial U}{\partial C}, \frac{\partial U}{\partial L \cdot H}, \frac{\partial U}{\partial P^1} > 0$$

The fact that the wife's leisure is weighted by her stock of human capital is meant to reflect the view that effective leisure time is enhanced by human capital and allows human capital to enter the utility function directly. The

fact that the number of surviving children is also included in the utility function is intended to reflect the direct consumption utility benefits, satisfaction, or prestige that the presence of children provide according to most attitudinal surveys of rural women in developing countries.

The production function for children (net of the endogenous component of infant mortality) of each sex j is assumed to depend on the time and care of the mother (weighted again by her human capital stock) on the mother's allocation of goods and services and on environmental factors specific to household Z_1, and to the community Z_2.

(2) $P^{1j} = P(L_t^j H_t^w, C_t^{1j}, Z_{1t}, Z_{2t})$ for j = m, f

where

$\partial P^j/\partial L^j H$, $\partial P^j/\partial C^{1j}$, and $\partial P^j/\partial Z$ are all positive, but the second derivatives are negative.

For example, the size and structure of the household, including the presence of grandmothers, and other providers of childcare, the quality of the house, and above all the age of marriage could all be relevant components of Z_1, and the distance from clinics or other public health facilities, the presence of sewage and potable water systems and so on could all be components of Z_2, which is intended to capture the exogenous component of infant mortality and hence of the cost of raising infants that survive into childhood.

We assume that the woman considers two periods--motherhood and widowhood. During motherhood--period 1--her husband is alive and she is given aggregate allocations of goods and services $\bar{C}$ and leisure $\bar{L}$ by the household head (from Stage III of the model). These are endowments beyond her control. During widowhood, however, she will be dependent on her sons. Her overall objective is to maximize her utility over her entire life span.

(3) $U = U(C_1^w, L_1^w H^w, P^{1m}, P^{1f}, \frac{C_2^w}{(1+d)}, \frac{L_2^w H^w}{(1+d)})$

where d is a subjective discount rate conditional on the relative importance of widowhood in her overall time horizon, which would depend among other things on the number of years she would expect to outlive her husband which, in turn, would depend on their relative ages and the sex-specific mortality rates, and the probability of remarriage, etc.

The wife-mother allocates both her given allocation of goods and services $\overline{C}$ and her leisure $\overline{L}$ between herself C^w and L^w, respectively, and the male and female children that she almost exclusively bears, nurtures, and cares for especially during the critical period immediately after birth, C^{1m} and L^{1f}. Her own consumption and leisure in period 1 are thus subject to the following constraints:

$$(4)\quad C_1^w = \overline{C}_1 - C_1^{1m} - c_1^{1f}$$

$$(5)\quad L_1^w = \overline{L}_1 - L_1^{1m} - L_1^{1f}$$

Her consumption of goods and leisure in widowhood, i.e., period 2, however, depend on the allocations of goods and leisure that she can expect to receive in the household(s) of her son(s) and daughter(s) which will depend on the number of children of each sex, their survival rates, their human capital stocks, which will depend in part on the human capital investments made in them (from Stage IV of the model) and also on their loyalty, which may depend in part on the care she provides them and on the living arrangements in period 1, E_1 (from Stage II of the model:

$$(6)\quad C_2^w = C(s_1^{1j}\ P^{1j}H^{1j},\ C_1^{1j},\ L_1^{1j}\ H^{1j},\ E_1)$$

$$(7)\quad L_2^w = L(s_1^{1j}\ P^{1j}H^{1j},\ C_1^{1j},\ L_1^{1j}\ H^{1j},\ E_1)$$

where the partial derivates of both C_2^w and L_2^w with respect to each of the specified arguments are positive but the second derivatives are negative.

The objective of the wife is to maximize (3) subject to the production function (2), and the current and future budget constraints on goods and services and time given by (4), (5), (6), and (7).

Without going into the details of the solution, the reader should be able to see that at the optimum the wife allocates her total allocation of goods and services and leisure between herself and her male and female children so as to equate the direct marginal utility of her own consumption of goods and services and leisure C_1^W and L_1^W with the indirect utility that allocations of these same goods and services and time to childbearing and childcare activities generate by way of the production function for the two types of children, which feed back into her utility function directly in the form of P^{1m} and P^{2m} and indirectly through the expected transfers she would receive in widowhood, which according to (6) and (7) depend in part on the number of such children of each sex but also on their loyalty which is again dependent on the wife-mother's resource and time allocations to the children.

Out of this solution comes, of course, the demand for surviving children of each sex, P^{1m} and P^{1f}, respectively. Note first of all that for several reasons the demands for surviving children may vary by sex. First, they may vary because of different preferences for male and female children directly in the wife-mother's utility function (1) and hence in (3). Second, they may vary because of differing survival rates from childhood into adulthood, S_1^{1j}. Third, and perhaps most importantly, they may vary because of the differing amounts of human capital investments that can be expected to be invested in them by the household head (in Stage IV) and the differing probabilities of receiving transfers in widowhood from male and female children.

Normally, mothers may be expected to want children of each sex, and hence birth-order effects are likely to be important in fertility decisions. Although the probability of a male birth presumably never varies much from .5, the probability of having a surviving male child can be raised relative to that of a surviving

female by the allocation of extra time and goods on the part of the mother to assure survival. Given the considerations of the previous paragraph, such sex-discriminatory allocations can be perfectly rational, and as was mentioned in Section I, this result is consistent with the empirical evidence.

The effect of education of the wife-mother on fertility might well be ambiguous, given that her human capital enters the demand for children in several ways--i.e., directly by increasing the efficiency of leisure in (1) and (3), via its efficiency enhancing effect in the production function for surviving children (2); and again by its efficiency-enhancing effect on loyalty training and hence on the probability of transfers from equations (6) and (7). Furthermore, the higher the human capital of the wife, the larger her total allocation of goods $\overline{C}$ by the household head is likely to be. The effect of her human capital stock on her total allocation of leisure, however, could well be negative given the higher opportunity cost of such leisure from the point of view of the extra wage income and home goods production foregone implicit in the higher level of human capital.

Although this formulation of the fertility-infant mortality "decision" may be unorthodox and extreme in specifying the decision to be that of the wife-mother, the model does allow for considerable influence of the husband and/or the household head. For example, any household head (or husband) could favorably affect the fertility decision by giving the wife-mother a larger allocation of the household's consumable goods and services and/or by decreasing her work responsibilities (and hence increasing her total leisure allocation) thereby increasing her demand for children quite unambiguously. In the case of the non-head husband such a reallocation of leisure and goods and services to the wife would have to be done by decreasing his own. If a husband wanted his wife to have more children than he thought she wanted to, given her allocation, it would, of course, be rational for him to give her some of his own allocation. The household head could also influence the wife-mother's demand for children by promising to invest more in the children's human capital or by adopting living arrangements favorable to the

receipt of transfers in widowhood. Indeed, in certain situations the effects of such allocational decisions by the household head could well be dominating, e.g., by leaving the wife with such a small allocation of goods and services and leisure that it would be very difficult for her to bear children who could survive into childhood.

Besides the effects of the wife's human capital stock and the allocations of time and goods to wives by husbands and household heads on fertility, in collaboration with the models of other stages, the model also incorporates the effects of many other variables that have been shown to influence fertility in other studies. For example, as has already been mentioned, age of marriage and probability of marriage are major determinants of completed fertility and other measures of overall fertility. These factors, determined in Stage V, would have a direct influence on fertility, since the age of marriage would be one of the more important household-specific influences included in the Z_1 vector which enters the production function for children in equation (2). In addition to the effect of the total allocation of leisure and goods to the wife which would presumably reflect, in part, her productivity in non-leisure activities (possibly including wage labor), it would be possible to amend the leisure variable to index the various other activities in which the wife is involved (as determined in Stage II) by their degree of compatibility with pregnancy and infant care to get a more precise index of the cost to the wife-mother of bearing children that can survive. The effect of household wealth, land tenure status, etc., on fertility could be realized both through the allocations of consumption and leisure to the wife which would presumably be related to household wealth and permanent income and also indirectly through the effect of the latter on household size and structure which affects fertility through equations (2), (6), and (7). Technological changes and changes in market prices for non-agricultural or agricultural goods or wage labor including that of children and/or women could exert their influence on fertility through reallocations of goods, services, and leisure in Stage III or of investments such as those in

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human capital in Stage IV, all of which could result in changing allocations to wives or in changing expectations of the human capital investments in children, and hence in the value of the expected transfers to be received from any given number of surviving children, or more indirectly through the changes in living arrangements (household structure) brought about by such changes.

According to our model the effectiveness of the introduction of an old-age pension system on fertility behavior would depend to a large extent on whether or not married women and in particular widows would be covered by the scheme. If they were covered, expected consumption during widowhood could be generated independent of one's children in general and one's sons in particular. Any such exogenous increase in expected future consumption and leisure streams might well lead to a substitution at the margin of current utility for future utility. This substitution of present for future would take several forms, such as greater own consumption by wives of the total allocations of goods and leisure they receive from household heads (which would presumably lower fertility net of infant mortality) or increases in allocations of time and goods toward one's children, because of the direct inclusion of children in the utility functions (1) and (3) (which would have the effect of raising the number of surviving children). On the other hand, if such a change would have the effect of lowering existing children's propensity to provide transfers, it could encourage particular kinds of allocations of the mother's time to children such as those allocations which would increase the loyalty coefficient in spite of the social security.

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Household Structure and Intergenerational Transfers

Virtually all societies provide some mechanism by which children and older adults are provided for by the productive population. The mechanisms, of course, vary and rely on a variety of institutions. In all cases, the feasibility of the mechanisms depends on the presence of a productive population. In addition, in all cases, there is some uncertainty which the dependent population faces with regard to the receipt of consumption goods. There are also various mechanisms by which persons when they are part of the productive population may decrease this uncertainty but not eliminate it.

Examples of institutions which provide the mechanisms by which resources are transferred from the productive to the dependent populations include the nuclear and extended family, non-profit benevolent organizations, private money markets, and governments with the power to tax. The mechanisms include the intrafamily tranfer, including bequests at death, from adults to their parents and to their children, private philanthropy through the intermediation of non-profit benevolent organizations, the use of savings and of private pension systems both based on private money markets, and governmental programs including social security and welfare systems. The mechanisms by which the uncertainty of receipt of the payment may be reduced include the maintenance of close and possibly joint living arrangements with children, the provision of contributions to charitable organizations when not in need and exhibiting behavior consistent with the charitable organization, the giving up of consumption in favor of savings when one is part of the productive population, and the support of measures to increase current taxes to allow for higher current benefits. At least initially, the various mechanisms seem similar.

However, it should be noted that these mechanisms are distinct and they are not perfect substitutes for one another. Nor is one mechanism superior to all other mechanisms. Thus, the introduction of either money markets or of social insurance systems will not necessarily eliminate the need to solidify relationships with children so as to ensure the receipt of transfers from adult children when one is old. However, it is suggested that the introduction of social insurance and money markets, by providing alternative mechanisms for old age support, is likely to influence household structures. A number of examples illustrating the interrelationships of intergenerational transfers and family structures have been documented by others (See Section I of this report Ben-Porath, 1977) and will not be reviewed at this point.

The objective of this section is to develop a model which recognizes that one of the functions of children is to provide support to dependent older persons and that parents, by maintaining close relationships with children through joint living arrangements and other means, may influence the probability that they will be supported by their children in their old age. The model or models, depending on one's point of view, are founded on the overlapping generations model introduced by Samuelson (1958) and more recently combined with neoclassical growth models for purposes of examining demographic issues such as optimal populations and fertility rates (Samuelson, 1975a, 1975b; Willis, 1979).

The first section considers a two sector life cycle growth model where family structure is recognizes to influence production, utility, and the level of transfers one expects to receive in the future. The model presented is, with the exception of the introduction of family structure, the same model considered by Samuelson (1975a, 1975b). Acknowledging the short comings of this model, the second section introduces a four-period model. In contrast to the previous model, differences in survival rates and marriage rates, both distinguished by sex, are incorporated. The additional complexities provide a means of dis-

cussing the influence of various cultural and institutional conditions in specific developing countries. Both the more complex model as well as the trimmed down versions differ from previously developed models in that vital rates including birth rates are taken as given initially, transfers received in old age are specified as functions of both living arrangements and the number of children, and total output is dependent on household structures.

I. Family Structure and Social Security in a Two-Period Life Cycle Growth Model

The starting point for the model considered in this section is a two-period life cycle growth model considered by Samuelson (1975a, 1975b). The major change is the introduction of intrafamily transfers and the explicit recognition that family structure influences output, individual utility derived from consumption goods, and current and future transfer income. Willis (1979) has focused on intrafamily transfers but was concerned only with adjustments in the number of births as a means of altering the level of transfers received in old age. The discussion proceeds with a review of the basic model and the general equilibrium solution as presented by Samuelson (1975a) and with an examination of the basic model augmented with the introduction of a family transfer and a social security system.

Two-Period Life Cycle Growth Model

As noted above, the Samuelson model (1975a) is a two-generation, asexual model. An individual is assumed to live for two periods, the first period as an adult who both consumes and produces output and the second period as a dependent elderly person who consumes output only. The well-being of a representative individual is given by a quasi-concave ordinal utility function, $u(c^1, c^2)$, where

c^1 and c^2 are per capita real consumptions for adult and dependent elderly (or young and old) persons, respectively. At time t, there are L_t adults and L_{t-1} dependent elderly persons (survival rates are ignored). The consumption totals for these two populations are $L_t c_t^1$ and $L_{t-1} c_t^2$. Recognizing that total consumption plus total investment must equal total output and assuming that production may be characterized by a constant returns production function, Samuelson (1975a) obtains:

$$L_t c_t^1 + L_{t-1} c_t^2 + K_{t+1} - K_t = L_t f\left(\frac{K_t}{L_t}\right)$$

$$u_t = u(c_t^1, c_{t+1}^2) .$$

Assuming balanced exponential growth, with

$$g = \frac{L_{t+1} - L_t}{L_t} = \frac{K_{t+1} - K_t}{K_t}$$

and with substitution for c^1, the problem may be stated as:[5/]

$$\max_{c^2\ k} u(f(k) - gk - \frac{c^2}{1+g^2}\ c^2) .$$

The optimal values, k_g and c_g^2, with $c_g^1 = f(k_g) - gk_g - \frac{c_g^2}{1+g}$, must satisfy:[6/]

$$f'(k_g) = g$$

$$\frac{u_1(c_g^1, c_g^2)}{u_2(c_g^1, c_g^2)} = 1 + g$$

The two relationships constitute a two-part golden rule.

The optimum g^* is obtained by the maximization of u_g over g. The problem

may be slated as:

$$\max_g u_g(f(k_g) - gk_g - \frac{c^2}{1+g}, c^2) .$$

The solution g* must satisfy:

$$0 = k_g + \frac{c_g^2}{(1+g^*)^2} ,$$

or

$$1+g^* = \frac{(c_g^2)^{\frac{1}{2}}}{k_g}$$

This optimal value of g* relationship is similar to the relationship derived for the efficient level of fertility by Willis (1979, p. 9) for a three generation model with no capital stock but with explicit survival rates.

At this point, the individual laissez-faire savings problem is considered. As noted by Samuelson (1975b), the laissez-faire savings problem is to maximize utility, $u(c^1,c^2)$, subject to the budget constraint, $c^1 + \frac{c^2}{1+r} = f(k) - rk$, evolves to:

$$c^1 + \frac{c^2}{1+r} = f(k) - rk$$

$$f'(k) = r$$

$$(\partial u/\partial c^1)/(\partial u/\partial c^2) = 1+r$$

$$(f(k) - rk) - c^1 \equiv \frac{c^2}{1+r} = k(1+g) .$$

The first equation is the steady state budget constraint, the second and third equations are the first order conditions, and the fourth equation is a result of the steady-state assumption and states that output which is neither consumed by the productive generation or invested, $f(k) - rk - c^1$, is reserved for con-

sumption in the following period. As noted by Samuelson (1975b), the solution to this problem will not be optimal unless $g = g^*$

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Life Cycle Growth Model with Social Security and Family Structure

At this point, the model is augmented to explicitly allow for household structure and a public social security system. Household structure is recognized to influence the level of output due to scale economies in production and to influence the utility obtained from a given set of goods due to scale economics in consumption and to preferences for either a large or small household. In addition, household structures and family growth rates are assumed to influence the level of transfers between generations.

Following Samuelson (1975b), social security is introduced by imposing a per worker tax of τ_1 and by providing a per capita benefit of β_1 to each dependent elderly person. The growth rate for the society is specified such that $L_{t+1} = L_t(1+g_1)$. An intrafamily transfer system is introduced by assuming that family members in the first period contribute a transfer, τ_2, to the support of the dependent elderly and that family members in the second period receive a benefit, β_2, for their support. The transfer, τ_2, is assumed to be a positive function of the size and structure of the household, E, and a negative function of the family's growth rate, g_2. In other words, the commitment to one's parents is positively influenced by a close or joint living arrangement and negatively influenced by the number of siblings one has. For similar reasons, the benefit, β_2, is a positive function of E and a negative function of g_2. The growth rate of the society, g_1, and as a consequence, the growth rate of contributors to the social security system is not necessarily equal to the growth rate of the individual family, g_1.

The budget identities for the steady state transfer system, including both the social security and family transfer systems, are now considered. (Note that there are no assurances at this point that the steady state is stable, unique, or even exists. The problem of insuring a stable steady state situation is

much more difficult than is implied by Samuelson (Gale, 1973). This discussion will continue assuming that a steady state exists and has been reached. For comparative statics, this approach is not unusual.) Since the growth rates for the family and for the society may differ, two distinct budget identities are required.

For the family, the budget identity for the steady state transfer system is:

$$(\beta_1 + \beta_2(E_t, g_2))L_{t-1} \equiv (\tau_1 + \tau_2(E_t, g_2))L_t + r_t k_t L_t - (k_{t+1}L_{t+1} - k_t L_t) + A ,$$

where A represents the difference in benefits and transfers from the social security system. If the family grows such that $L_t = L_{t-1}(1+g_2)$ and transfer system is in a steady state, the above equation may be written as:

$$(\beta_1 + \beta_2(E, g_2))/(1+g_2) \equiv \tau_1 + \tau_2(E,g_2) + k^s(1+r) - k^s(1+g_2) + \frac{A}{L_t} ,$$

where k^s is social capital and $k - k^s$ is private capital. For the society, the budget identity in the assumed steady state will differ in that g_1 will replace g_2 and the term A/L_t will disappear. This suggests that the term $\frac{A}{L_t}$ is a function of g_1 and g_2 at the family level.

For the individual who lives for two time periods and faces an interest rate r, the budget constraint in the steady state situation is:

$$c^1 + c^2/(1+r) = f(k,E) - rk - \tau_1 - \tau_2(E,g_2) + (\beta_1 + \beta_2(E,g_2))/(1+r) + \frac{A}{L_t}$$

The problem facing the individual is to maximize utility, $u(c^1,c^2,E)$ subject to the above constraint. The result of this optimization is a set of five equations for determining the five unknowns. In all cases, the value of the unknowns will be dependent on τ_1, k^s, and the parameters of the production function, utility function, and family transfer functions. By substitution of the budget identity into the budget constraint and by maximization of utility given the budget con-

straint, one obtains[7]:

$$\text{(i)} \quad \frac{\partial u}{\partial c^1} \Big/ \frac{\partial u}{\partial c^2} = 1 + r$$

$$\text{(ii)} \quad \partial f/\partial k = r$$

$$\text{(iii)} \quad \frac{\partial u}{\partial E} = \frac{\partial u}{\partial c^1}\left[-\frac{\partial f}{\partial E} + \frac{\partial \tau_2}{\partial E} - \frac{1}{1+r} \quad \frac{\partial \beta_2}{\partial E} \right]$$

$$\text{(iv)} \quad c^1 + \frac{c^2}{1+r} = f(k,E) - rk - \tau_1 - \tau_2(E,g_2) + (1+r)^{-1}(1+g_2)[\tau_1 + \tau_2(E,g_2) + d^s(r-g_2) + \frac{A}{L_t}]$$

$$\text{(v)} \quad \frac{c^2}{1+r} + (1+r)^{-1}(1+g_2)[\tau_1 + \tau_2(E,g_2) + k^s(r-g_2) + \frac{A}{L_t}] = (k - k^s)(1+g_2)$$

Samuelson (1975b) in the equivalent situation suggested that the incidence of a change in τ_1 or k_s could be examined by "straightforward total differentiation" of the set of five equations. However, to derive an explicit relationship between E, the indicator of household structure, and the other exogenous variables, assumptions of specific functional forms is required. Equation (iii) does provide evidence that the change in utility due to a change in family structure is related to the change in output and to the changes in transfers and benefits resulting from the change in E. Equation (iv) and (v) indicate that the optimal E will depend on the interest rate, the growth rate of the family and parameters describing the social security program.

II. A Detailed Four-period Life Cycle Growth Model

The two period model presented in Section I introduced household structure into a life cycle growth model. The optimal household structure was recognized to depend on economies of scale in production on economies of scale in consumption and cultural preferences regarding household size, and on the extent to which maintenance of specific household structures influences the level of

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transfers. By including both family and society level transfer programs, the model also suggested the potential influence of the introduction of a meaningful social security program on household structures. The simplicity of the model allowed attention to be focused on the basic relationship between household structure, production, and various intergenerational transfer mechanisms.

However, the simplicity of the model also limits its usefulness. As noted by Arthur and McNicoll (1978), the restriction to two periods effectively means that the costs of children both to private individuals and to society at large are ignored. In addition, the exclusion of sex differences means that sex differences in survival rates as well as the complex process of marriage are not dealt with explicitly. When attention has been focused on the first problem, the solution appeared to be the adoption of either an n+1 period or a continuous time model (Gale, 1973; Arthur and McNicoll, 1978). With attention to be focused on household structure and the accompanying importance of distinguishing nuclear families from extended families, the adoption of n+1 period or continuous time framework is not a satisfactory solution.

The model to be presented in this section, while simple in comparison to the so-called "real world", is considerably more complex than the majority of the overlapping generations model on which it is based. Four generations in contrast to two or three generations are introduced; birth rates, or more aptly the probabilities of survival to age one, are sex-specific; remaining survival probabilities are sex specific; marriage rates have the effect of adding a person of one sex to the family when an outsider "marries-in" to the family and subtracting a person of a particular sex when a family member "marries out". In most societies, and in particular in India the first country to which the model is to be applied, it is more common for female members of the family to "marry-out" and for male members to remain in the household upon marriage, bringing

their wives into the family. Therefore, we shall assume that, when a female family member marries, the size of the family is reduced by one female member and that when a male marries, family size is increased by one female member. Production in each period is assumed to be dependent on household structure in the current period and transfers are dependent on current and previous household structures. Despite these additional complexities, the model is similar to previously developed models and specifically to the model presented in the previous section. A unique role is given to the "family" defined as the set of individuals composing the four generations.[8/] Other similarities include the assumption of one non-storeable good which can be used either for consumption or investment purposes and the characterization of the production process by a constant returns to scale production func. on given household structure.

Before the four period, two sex model is considered, it should be noted that it is unlikely that an analytical solution to the model will be obtained. Theoretical issues regarding the existence of stable steady states are currently a subject of serious research by certain economists, and similar issues for a model approaching the complexity of the model to be described have not been considered. Nevertheless, the unrealistic nature of the two-period model has led to the development of the four-period model. Potentially, the four-period model may be used in a simulation model. In addition, the model as presented suggests many of the complexities which are relevant in a developing country context.

In the complex model to be considered, each individual is assumed to live for four equal time periods subject to survival rates. The four time periods or generations represent children, young adults, mature adults, and elderly. As will be made more precise, children and elderly are not productive, relying on transfers from young adults and mature adults, the two productive generations. In addition to the distinction between productive and non-productive generations, children differ from young adults in that children are permanently attached to their respective parents while young adults are able to disassociate themselves from their parents and to establish new households if they so choose to. There is, of course, a cost associated with disassociation due to economies of scale in production and consumption and to the negative relationship between disassociation and receipt of inheritance. The benefits of disassociation result from diseconomies of scale in production and consumption and from reduced claims or output from other generations such as elderly parents.

At this point, we proceed to a formal specification of the problem. This includes specification of populations by generation given survival probabilities, specification of the household production functions, specification of individual consumption by sex and generation, and specification of individual utility functions. Given the population, output, and consumption, the feasibility condition for general equilibrium in which output is required to be equal or greater than consumption in each time period would then be considered. The specification of the individual maximization problem would then follow.

a. Population

The number of males and the number of females in any one generation for a representative mature couple depends on sex-specific births by generation, sex-specific survival rates, sex-specific constants representing the probability that children born to mature couples are young adults and potential family heads, sex-specific marriage rates, and sex-specific rates indicating separation from family. This last rate allows for the possibility that young adults do not remain attached to their own family but are adopted by the family of their mate. In most of India the custom is for females to marry-in although there are examples where a male has been adopted by the family of his wife at the time of the marriage. Sex-specific births by time period are represented by $B(t, i)$ with t representing time and i representing sex with $i = m$ for males and $i = f$ for females. $B(t,i)$ may be interpreted as the average number of children implying that adjustments for infant and child mortality have been made. Survival rates are presented as conditional survival rates and are specific by time, sex, and generation, $s(t,1,j)$, with j representing generation, $s(t, i, 1)$ represents the probability the male child survives to young adulthood. The marriage or nuptial rates apply only to young adults and are specified as $n(t,i)$. The nuptial rate $n(t,1)$ is interpreted as the proportion of young adult males who are married. The case of marrying-in or addition to family is handled by the rate, $a(t,i)$, which is interpreted as the proportion of the ith sex who remain in the family following marriage. As a consequence, the rate, $1 - a(t,i)$, is the proportion of the ith sex who separate from family. (The rate refers to separation from family and not from household or households.) Two final constants, $d(t,i)$, are needed to determine the proportion of children born to mature adults who have yet to come of age.

Given the various constants described above, the population by sex, generation, and marital status of the family attached to the mature couple may be described. With P(t,x,i,j,k) representing population, the population sizes are specified in Table 1.

Table 1

Population by generation, sex, generation of parents, and marital status

I. Children

A. Males

Mature adult parent:

$$P(t,1,m,3,1) = a(t,m) * B(t-1,m)$$

Young adult parents:

$$P(t,1,m,2,1) = [P(t,2,m,3,2) + P(t,2,f,3,2)] * B(t-1,m)$$

B. Females

Mature adult parents:

$$P(t,1,f,3,1) = d(t,f) * B(t-1,f)$$

Young adult parents:

$$P(t,1,f,2,1) = [P(t,2,m,3,2) + P(t,2,f,3,2)] * B(t-1,f)$$

II. Young Adults

A. Males

Single sons:

$$P(t,2,m,3,1) = (1-n(t,m)) * s(t,1,m) * (1-d(t,m)) * B(t-1,m)$$

Married sons:

$$P(t,2,m,3,2) = a(t,m) * n(t,m) * s(t,1,m) * (1-d(t,m) * B(t-1,m)$$

Son-in-laws:

$$P(t,2,m,3,3) = a(t,f) * n(t,f) * s(t,1,f) * (1-d(t,f)) * B(t-1,m)$$

B. Females

Single daughters:

$$P(t,2,f,3,1) = (1-n(t,f)) * s(t,1,f) * (1-d(t,f)) * B(t-1,f)$$

Married daughters:

$$P(t,2,f,3,2) = a(t,f) * n(t,f) * s(t,1,f) * (1-d(t,f)) * B(t-1,f)$$

Daughter-in-laws:

$$P(t,2,f,3,3) = a(t,m) * n(t,m) * s(t,1,m) * (1-d(t,f)) * B(t-1,f)$$

III. Mature adults

Males:

$$P(t,3,m,4,2) = 1$$

Females:

$$P(t,3,f,4,2) = 1$$

IV. Dependent elderly

Father of mature adult male:

$$P(t,4,m,5,2) = s(t,3,m) * s(t-1,2,m) * 1$$

Mother of mature adult females

$$P(t,4,f,5,2) = s(t,3,f) * s(t-1,2,f) * 1$$

b. Production

The basic production unit is the household. The family described previously may be distributed across several households or may comprise only one household. In either case, production is limited to one non-storeable good which is used either for consumption or investment. Labor and capital, L and K, are used to produce output through a constant returns production function given household structure, E. Output is also divided between consumption goods and investment goods. This statement is expressed as

$$Q = F[K(t), L(t), E(t)] = C(t) + K(t)$$

As suggested, a production function is associated with each household or household head.

c. Consumption

Individual consumption for a given time period is determined by births, by survival and marriage rates, by current levels of output and levels of capital stock, and by transfer policies, both within the family and within the larger society. The level of intrafamily transfers is dependent on current and previous household structures and on survival and marriage rates. In other words, one's obligation to one's parents depends in part on the extent to which a close household relationship has been maintained and on the number of brothers and sisters available for sharing the burden. Positive family transfers or benefits per person are β_2 and negative family transfers or taxes are τ_2. The level of transfers from the larger society are characterized by a social insurance system similar to the system considered by Samuelson. The level of per person benefits, β_1, are financed by a tax, τ_1, on the productive generations. Only the dependent elderly are eligible for the benefits β_1. At the societal level, an identity insuring benefits equal taxes plus a decrease in capital stock is required. At

micro-level, the per person benefits, β_1, and the proportional tax rate, τ_1, are taken as given and need not balance. Individual consumption streams are specified in Table 2. Note that output, Q, is associated with a household head. If the individual is not a household head, output equals zero.

Table 2

Consumption streams by generation, sex, parents and marital status.

I. Children

A. Males

Young adult parents:

$$c(t,1,m,2,1) = \beta_2(t,1,m,2)$$

Mature adult parents:

$$c(t,1,m,3,1) = \beta_2(t,1,m,3)$$

B. Females

Young adult parents:

$$c(t,1,f,2,1) = \beta_2(t,1,f,2)$$

Mature adult parents

$$c(t,1,f,3,1) = \beta_2(t,1,f,3)$$

II. Young Adults

Single son

$$c(t,2,m,3,1) = Q(t,2,m,3,1,E) - \tau_1 + \beta_2(t,2,m,3,1,E)$$

Married son and daughter-in-law

$$\begin{aligned} c(t,2,m,3,2) = {} & Q(t,2,m,3,2,E) - 2\tau_1 + \beta_2(t,2,m,3,2,E) \\ & - \beta_2(t,1,m,2,1,E) * B(t,m,1) \\ & - \beta_2(t,1,f,2,1,E) * B(t,f,1) \end{aligned}$$

Single daughters

$$c(t,2,f,3,1) = Q(t,2,f,3,1,E) - \tau_1 + \beta_2(t,2,f,3,1,E)$$

Married daughter and son-in-law

$$\begin{aligned} c(t,2,f,3,2) = {} & Q(t,2,f,3,2,E) - 2\tau_1 \\ & + \beta_2(t,2,f,3,2,E) \\ & - \beta_2(t,1,m,2,1,E) * B(t,m,2) \\ & - \beta_2(t,1,f,2,1,E) * B(t,f,2) \end{aligned}$$

III. Mature Adult Couple

$$\begin{aligned} c(t,3,m,4,2) = {} & Q(t,3,m,4,2,E) - 2\tau_1 \\ & + \sum_{i=1,2,4} \sum_{j=m,f} \sum_{k=3,5} \sum_{l=1,2} \beta_2(t,i,j,k,l) * P(t,i,j,k,l) \end{aligned}$$

IV. Dependent Elderly

Father of mature male

$$c(t,4,m,5,2) = \beta_2(t,4,m,5,2) + \beta_1$$

Mother of mature male

$$c(t,4,f,5,2) = \beta_2(t,4,f,5,2) + \beta_1$$

d. Individual Tastes

Individuals are assumed to have ordinal utility functions with consumption and household structures in the various periods of life as arguments. These utility functions may be represented as

$$u_t = u(c(t-1,1),\ c(t,2),\ c(t+1,3),\ c(t+2,4),\ E(t),\ E(t+1),\ E(t+2))$$

Children do not make decisions determining their household structure and their consumption is determined by their parents. The consumption of children

this period does influence their transfers in the future and thus is explicitly included.

Some of the difficulties of introducing sex and allowing for marriage become apparent at this point. (Note a much more detailed discussion of this problem is possible.) One possibility is to ignore the utilities of women and to only consider the utilities of males. The consumption in the second period depends on the marriage rate but as long as these are given this does not present a problem.

For the remainder of the discussion, males are assumed to be the only decision makers and their preferences are specified by the utility function.

e. Directions for Solutions

As suggested by the treatment of the two period model in the previous section, one may expect an optimal household structure to result from the model. The optimal household structure will depend on the demographic variables introduced including births, survival rates, and marriage rates. In addition, the influence of household structure on productivity, transfers, and utility as well as parameters of the social security system will also contribute to the optimal structure.

Some potential results with regard to the determinants of family structure may be suggested. First, increases in the benefits derived from the social security are likely to decrease the gains from the family transfer, β_2, and thus discourage extended family households. Second, when the optimal household size is reached in terms of production criteria, additions to extended family household are likely to encourage split offs of young married adults and their children. Third, when cultural preferences are such to reward extended family households by prestige, the extended family household may be found in higher income families despite potential losses in production which are incurred.

The reverse situation in which preferences call for smaller households (common in U.S. possibly) also results in production losses. As well as these results, a variety of other explanations of the determinants of household structure could be considered.

Conclusion

This discussion of multiple generation models has been designed to explore the determinants of household structures which are tied to the intergenerational support system. The two period model was presented to emphasize the basic structure of the multiple generation model and to consider some of the potential influences of family structure. The four-period model which followed emphasized the complexities involved in altering these models to incorporate some of the complexities relevant to the developing country situation. An analytical solution was not explored with the explanation that the framework is suggestive of a household structure relationship and is possibly more appropriate for a simulation exercise.

Stage III. Household Resource Allocation - Static Analysis

This stage of the analytical framework being presented is concerned with the allocation of the household's basic resources - time, assets and transfer income - across a set of activities. The decision maker is the household or household head and the objective is the maximization of household utility, a function of the agricultural, non-agricultural, household, and leisure goods consumed. The set of activities include agricultural production, household production, leisure, and purchase of both consumption goods and production goods. The resource allocation decisions in this stage are constrained by human capital and physical investment decisions considered in Stage IV.

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Some of the other relationships between this and other stages are noted below. First, the structure of the household is given having been determined in Stage II, the intergenerational life cycle model. The human capital embodied in the household members and the physical capital available for production are both determined in Stage IV. A result of the model is a shadow wage for children, a variable which is exogenous to the fertility model of Stage I. In addition, estimates of the household output conditioned by family structure also result.

The basic approach used draws heavily on the household production model formalized by Becker (1965) and others. Of particular relevance are two studies in which the household production model was adapted for the study of fertility in the contexts of developing countries (Rosenzweig and Evanson, 1977; Makhija no date). The model presented in this section contrasts with these previously presented models in that fertility is taken as exogenous.

Presentation of Model

As noted previously, the decision maker is the household or household head and the objective is to maximize household utility, u. The parameters of the utility function include agricultural goods, C_A, non-agricultural goods, C_N, household goods, C_H, and effective leisure time of all family members, $P\ H\ T_L$ where P is a vector of the number of persons by specific characteristic, H is a vector of embodied human capital or equivalent labor units, and T_L is a vector of time inputs to leisure. The household's preference function may be represented by:

$$u = u(C_A,\ C_N,\ C_H,\ P\ H\ T_L)$$

Since all agricultural and non-agricultural goods are purchased inputs, X_A and X_N, and all household goods produced, Q_H, are consumed, the above relationship is equivalent

$$u = u(X_A,\ X_N,\ Q_H,\ P\ H\ T_L)\ .$$

The production of agricultural goods, Q_A, is characterized by one aggregate production function,

$$Q_A = f(R_A, X_{AN}, W, (H\ P)'T_A)),$$

where R_A represents land and capital inprovements, X_{AN} represents purchased inputs from non-agricultural sector, W represents units of labor, and $(P\ H)'T_A$ represents total of unpaid equivalent units. The land and and other physical assets, R_A, the number of persons, P, and their human capital, H, are given for this model.

The production of household goods, Q_H, is also characterized by one aggregate production function,

$$Q_H = g(R_H, X_{HN}, (H \cdot P)' \cdot T_H)) ,$$

with terms defined as before. Similarly, the characteristics of the household capital, R_H, the number of persons, P, and the corresponding units of human capital, H, are given. The exogenous investments in agricultural and household capital and human capital require inputs of market goods (X_{RA}, X_{RH}, and X_{RE}) and of time (T_{RA}, T_{RH}, and T_{RE}).

The money income constraint requires that the market value of purchased inputs equal the money income earned or received plus any change in the household's money asset position. Money income is the result of unearned income from assets and from transfers by way of the government and family, agricultural income, and wage income. With the notation noted below, the money income constraint is:

$$\bar{q}_{RA}C_A + \bar{q}_{XN}C_N + \bar{q}_{XH}X_H + \bar{q}_{RA}\ X_{RA} + \bar{q}_{RH}X_{RH} + \bar{q}_{RE}X_{RE}$$
$$= V + TR_E + TR_O + \bar{q}_{QH}Q_A - \bar{q}_{XA}X_A - \bar{q}_w W + \bar{q}_w(HP)'\ T_w$$

where

$\bar{q}$ = market prices for corresponding inputs or outputs

v = assets

TR_G = net transfers from government

TR_O = net transfers from others not included in household

T_W = vector of time inputs to paid labor.

Agricultural income is represented by $\bar{q}_{QA}Q_A - \bar{q}_{RA}X_A - \bar{q}_W W$ or π_A and wage income of family members is represented by $\bar{q}_W(H \cdot P)' T_W$ where $\bar{q}_W$ is market wage per unit of human capital and, as a result, $\bar{q}_W H$ is interpreted as a vector of individual wage rates. The remaining terms on the right hand side represent unearned income while the terms on the left hand side represent the cost of purchased inputs plus the cost of investment in agricultural and household investment as determined in Stage IV of the model.

The time constraint for the models using vector notation is:

$$T = T_A + T_N + T_W + T_L + \bar{T}_{RE} + \bar{T}_{RA} + \bar{T}_{RH}$$

where $\bar{T}_{RE}$ represent a vector of time allocated to human capital investments by type of individual and $\bar{T}_{RA}$ and $\bar{T}_{RH}$ represents time inputs to agricultural and household investments. The amount of time allocated by the household to education, agricultural and household investment is determined also in Stage IV. For purposes of simplication of notation, exogenous inputs of goods and time are represented by

$$\Delta K = \bar{q}_{RA}X_{RA} + \bar{q}_{RH}X_{RH} + \bar{q}_{RE}X_{RE}$$

$$\bar{T}_K = \bar{T}_{RA} + \bar{T}_{RH} + \bar{T}_{RE}$$

$$A = V + TR_G + TR_O$$

Combining the money income and time constraints, one obtains the following full income constraint:

$$\bar{q}_{XA}C_A + \bar{q}_{XN}C_N + \bar{q}_{XN}X_N + \Delta\bar{K} + q_w(H\cdot P)'(T_A+T_N+T_L+\bar{T}_K)$$

$$A + \pi_A + \hat{q}_w(H\cdot P)'T + (q_w - \hat{q}_w)(H\cdot P)'T_w$$

The problem of the household decision maker is to maximize utility subject to the full income constraint, the agricultural production function, and the household production function. The result is a set of demand equations both for inputs to the utility function and for inputs to the production functions for agricultural and household goods.

The Optimum Allocation of Resources

By using traditional Lagrangian optimization techniques, the optimum allocation of the household's resources in the one period model may be determined. Stated formally, the problem is to

$$\max \quad u\,(C_A,\ C_N,\ C_H,\ P\ H.T_L)$$

subject to

$$Q_A = f(R_A,\ X_{AN},\ W,\ (PH)'\ T_A)$$

$$Q_H = f(R_H,\ X_{HN},\ (PH)'\ T_H)$$

$$\bar{q}_{CA}C_A + \bar{q}_{CN}C_N + \bar{q}_{XN}(X_{AN} + X_{HN}) + \Delta\bar{K} + q_w(H\cdot P)'(T_A+T_H+T_L+\bar{T}_K)$$

$$= A + \pi_A + \hat{q}_w(H\cdot P)'T + (\bar{q}_w - \hat{q}_w)(H\cdot P)'T_w$$

Since household production is consumed, it is also recognized that $Q_H = C_H$.

The Lagrangian and first order conditions for this optimization problem are:

$$h = u(C\ ,\ C\ ,\ Q\ ,\ P\ H\ T_L)$$
$$- \ {}_1[\bar{q}_{CA}C_A + \bar{q}_{CN}C_N + \bar{q}_{XN}X_{HN} + \Delta\bar{K} + \hat{q}_w(H\cdot P)'(T_A+T_H+T_L+\bar{T}_K)$$

$$- A - \pi_A - \hat{q}_W(P\cdot H)'T - (\overline{q}_W - \hat{q}_W)(P\cdot H)'T_W]$$

$$- \lambda_2[Q_A - f(R_A, X_{AN}, W, (P\cdot H)'T_A]$$

$$- \lambda_3[Q_H - g(R_H, X_{HN}, (P\cdot H)'T_H)].$$

$$\frac{\partial h}{\partial C_A} = \frac{\partial u}{\partial C_A} - \lambda_1 \overline{q}_{CA} \leq 0$$

$$\frac{\partial h}{\partial C_N} = \frac{\partial u}{\partial C_N} - \lambda_2 \overline{q}_{CN} \leq 0$$

$$\frac{\partial h}{\partial Q_H} = \frac{\partial u}{\partial Q_H} - \lambda_3 \leq 0$$

$$\frac{\partial h}{\partial T_{iL}} = P_i H_i \frac{\partial u}{\partial T_{iL}} - \lambda_1 \hat{q}_W (H_i P_i) \leq 0$$

$$\frac{\partial h}{\partial X_{HN}} = -\overline{\lambda}_1 q_{XN} + \lambda_3 \frac{\partial g}{\partial X_{HN}} \leq 0$$

$$\frac{\partial h}{\partial T_{iA}} = -\lambda_1 \hat{q}_W (H_i P_i)' + \lambda_2 P_i H_i \frac{\partial f}{\partial T_{iA}} \leq 0$$

$$\frac{\partial h}{\partial T_{iH}} = -\lambda_1 \hat{q}_W (H\cdot P)' + \lambda_3 P_i H_i \frac{\partial g}{\partial T_{iH}} \leq 0$$

$$\frac{\partial h}{\partial T_{iW}} = +\lambda_1 (\overline{q}_W - \hat{q}_W) P_i H_i \leq 0$$

$$\frac{\partial h}{\partial W} = -\lambda_1 \overline{q}_W + \lambda_2 \frac{\partial f}{\partial W} \leq 0$$

$$\frac{\partial h}{\partial X_{AN}} = -\lambda_1 \overline{q}_{XA} + \lambda_2 \frac{\partial f}{\partial X_{AN}} \leq 0$$

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In addition, the budget and production constraints or the partials of h with respect to shadow prices are also included. This set of first order conditions will result in demand equations both for inputs to the utility function and for inputs to the agricultural and household production functions. If production functions are assumed to be characterized by constant returns to scale, shadow prices for inputs to utility function may also be presented.

Stage IV. Household Resource Allocation - Dynamic Analysis

In the previous stage of the model, the allocation of the household's resources were considered for one period. Resources allocated to investments in agricultural and household capital and to investments in human capital were assumed given. In this section, the allocation decisions for these investment decisions are considered. A life cycle model with inputs of time augmented by human capital is presented and of market goods is presented. The model is a Heckman type model (1976) with an agricultural production function added. At this point, the basic relationships are described but no solution is considered. As in Stage III, the household or household head is the decision maker. The separation of the static and dynamic sectors may be justified by placing specific requirement on utility or preference functions. The separation also allows attention to be focused on relatively distinct problems, allocation of resources among alternative activities in a given time period and allocation over time.

Household preferences are described by a time indexed utility function with three types of parameters: purchased agricultural inputs, $C_A(t)$, household produced inputs, $C_A(t)$, and leisure time augmented by human capital for each household member, $H(t) \cdot P(t) \cdot T_L(t)$. Note that human capital enters directly

into the utility function as in Stage III. However, the set of inputs included in Stage III have been simplified to the three inputs, with non-agricultural inputs excluded. The time dependent preference or utility function is:

$$u(C_A(t),\ C_H(t),\ P(t)\ H(t)\ T_L(t))$$

Following the Heckman (1976) model, the production of human capital is described by:

$$\dot{H}(t) = f[H(t)\ T_E(t),\ X_{RE}(t)] - \sigma H(t)$$

$$H(0) = H_0\ ,$$

where T_E is time devoted to human capital production, X_{RE} is bundle of goods devoted to human capital production, and σ is a depreciation parameter.

The production of agricultural and household capital are characterized in a parallel fashion by:

$$\dot{R}_A(t) = f[H(t)\ T_{RA}(t),\ X_{RA}(t)] - \sigma R_A(t)$$

$$R_A(0) = R_{A0}$$

$$\dot{R}_H(t) = f[H(t)\ T_{RH}(t),\ X_{RH}(t)] = \sigma R_H(t)$$

$$R_H(0) = R_{H0}$$

A convenient assumption and generally reasonable is that the production functions are strongly concave. Additional factors influencing the production processes such as distance from market areas and schools may be readily incorporated into the above production functions for the various capital goods.

The budget constraint facing the individual household incorporates the incentives for human capital by the assumed positive relationship between human capital and potential earnings and for agricultural and household investment

by the assumed positive relationship between increases in capital stock and output. Introducing the time constraint, the relationships presented in the previous section for earnings, agricultural output, and household output may be rewritten as:

$$\text{Earnings}(t) = \overline{q}_W(t)'(H(t)\ P(t))'\cdot T_W(t)$$

$$Q_A(t) = f(R_A(t),\ X_{AN}(t),\ W(t),\ (H(t)\cdot P(t))'\cdot T_A(t))$$

$$Q_H(t) = g(R_H(t),\ X_{HN}(t),\ (H(t)\ P(t))'\cdot T_H(t))\ .$$

The income from agricultural production is as in the previous stage of model:

$$\overline{q}_{QA}(t)*Q_A(t) - \overline{q}_{AN}(t)\cdot X_{AN}(t) - \overline{q}_W(t)\cdot W(t).$$

The budget constraint, a constraint requiring that expenditures in given time period equal output plus any change in the asset position of the household, may be expressed as:

$$\begin{aligned}\dot{A}(t) = {} & rV(t) + TR_G(t) + TR_O(t) \\ & + \overline{q}_{QA}(t) * Q_A(t) - \overline{q}_{AN}(t) * X_{AN}(t) - \overline{q}_W(t)*W(t) \\ & + \overline{q}_W(t) * (H(t)*P(t))' * T_A(t) \\ & - q_{AN}(t) * C_A(t) \\ & - \overline{q}_{RE}(t) * X_{RE}(t) - \overline{q}_{RA}(t) * X_{RA}(t) - \overline{q}_{HA}(t) * X_{HA}(t).\end{aligned}$$

The change in capital stock position or savings is required to equal income from assets plus transfer, income from agricultural output, wage income, and expenditures on agricultural inputs in utility function and on agricultural and non-agricultural inputs to production of agricultural, household and human

capital. Parallel to the model presented is Stage II, time is also constrained in that $T = T_A + T_H + T_W + T_L + T_{RA} + T_{RH} + T_E$.

The household in this model is assumed to maximize the time-preferance-discounted stock of total utility over the horizon T or lifetime of household: Allowing ρ to be the rate of time preference and B( ) to be the bequest function, the household's life cycle utility function is:

$$\int_0^T e^{-\rho t} U[C_A(\tau),\ C_H(t),\ (H(t)\cdot P(t))'] \qquad + B[A(T)].$$

The problem facing the consumer is to maximize life time utility subject to constraints on the production of agricultural goods, on the production of household goods, on the production of agricultural and household capital inputs, on the production of human capital, and on the budget constraint.

While dynamic optimization techniques are available for obtaining explicit optimal time paths for the endogenous variables, the following discussion will only suggest some of the time paths which are likely to result. The emphasis will be explicitly on those endogenous variables which are of particular importance in other stages of the model. These include human capital of household members, consumption of household goods, and consumption of agricultural goods. In all cases, since the return to investments in agricultural and non-agricultural capital and in human capital are greater the earlier the investment, the stocks of agricultural, household, and human capital are expected to increase more rapidly in the earlier stages of the household than in later stages. However, this traditional pattern of human capital investments will be revised in the direction of greater stocks in later time periods to the extent that bequests are of major importance, to the extent that human capital enters utility function and to the extent that the production functions are charac-

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terized by increasing returns to scale. The actual level of agricultural and household capital stocks and of human capital stocks are also expected to be positively related to the marginal products of capital goods in the production functions. The actual levels will also depend on the gain in utility obtained from agricultural goods consumption as opposed to leisure time augmented by human capital.

The suggestion of this model is that investment decisions are the result of choices on the part of the household. These choices are influenced by a variety of demographic and economic variables. The levels of investment will both directly and indirectly influence fertility, household structure, and a variety of other variables. Increases in social security will undoubtedly decrease investments at later points in the life cycle and investments in children by household head. This aspect of the model can be examined by focusing on changes in asset positions.

E. Stage V: Marriage

The purpose of this stage is admittedly rather unambitious. It is primarily to close the model by explaining the age-specific probabilities of marriage for each sex. These probabilities are required in several of the previous stages. First, the age of marriage of the prospective wife is likely to be an important determinant of completed fertility as an element in the vector Z, of household characteristics that was included in the production function of children, equation (2) of Stage I. Second, the difference in age of marriage between husbands and wives is an important determinant of the discount rate d used in equations (6) and (7) of Stage I to weight the relative importance of widowhood and hence of dependence on one's children in the lifetime planning horizon. Third, the sex-specific probabilities of marriage are required in Stage II in order to determine household structure in any period of time. Although not specifically introduced into our formal model of Stage II (for purposes of simplicity only), our review of the literature in Section I of this report indicated that the anticipation of the marriage of the child of one of one's siblings can be of consequence to the household affiliation decision, especially when the cost of marriage, i.e., either the dowry or alternatively the bride price payable at marriage, is high. Similarly, an exogenous demand on the household budget such as a dowry or bride price payment could conceivably be of importance in the static and dynamic allocations of the household's resources in Stages III and IV, respectively.

The requirements of Stage V, therefore, are only to explain the probability of marriage for each age and sex and the bride price or dowry required upon marriage of a son or daughter, respectively.

The probability of being married before the age of puberty and young adulthood or generation 2 in terms of the nomenclature of Stage II, although certainly greater than zero, is disregarded. Although formally marriages can be arranged and consumated prior to this age, seldom are such marriages effective in the sense that either the structure of the household (by a shift in residence of at least

one marriage partner) or the number of children that such a marriage produces are affected.

The probability of being married at any particular chronological age q after the age which is designated as the end of childhood and beginning of young adulthood for males and females, c_q^{2m} and c_q^{2f}, respectively, can be expressed as follows:

$$\text{(V-1)} \qquad c_q^{2m} = f(\overset{-}{H_q^{2m}}, \overset{+}{\frac{C_q^{2m}}{C_{q+t}^{2m}}}, \overset{+}{\frac{K_A}{\sum_{ij} p^{ij}}}, \overset{+}{\frac{R}{\sum p^{ij}}}, \overset{+}{\frac{K_H}{\sum_{ij} p^{ij}}}; E)$$

$$\text{(V-2)} \qquad c_q^{2f} = g(\overset{-}{H_q^{2f}}, \overset{-}{C_q^{2f}}, \overset{-}{\frac{K_A}{\sum_{ij} p^{ij}}}, \overset{-}{\frac{R}{\sum_{ij} p^{ij}}}, \overset{-}{\frac{K_H}{\sum_{ij} p^{ij}}}; E)$$

where H_q^{2m} and H_q^{2f} are the stocks of human capital at age q of young adult males and females, respectively, $\frac{C_q^{2m}}{C_{q+t}^{2m}}$ represents the male's current allocation of consumption goods relative to his expected future allocation, $\frac{K_A}{\sum_{ij} p^{ij}}$, $\frac{R}{\sum_{ij} p^{ij}}$ and $\frac{K_H}{\sum p^{ij}}$ represent the per capita stocks of agricultural capital, land, and home goods (which includes housing) and E represents the structure of the household, including, for example, the number of siblings in the household. The signs above the variables indicate the anticipated signs of the partial derivatives of the variables specified in the equations.

The higher the level of educational attainment the lower would be the probability of being married for both sexes at any age q, although possibly only up to some threshold age level beyond which the level of education might actually have a positive effect on the probability of being married. The negativity of this effect could be derived from a number of sources such as the delaying effect of being in school since marriage requires time, the potential interest of the household head in making additional investments of human capital in the individual male or female under consideration, and of any indirect detrimental influence on interest

in marriage that the educated young adult might be able to exercise on the decision of the household head.

The direction of the influence of the second term in the young adult male's probability-of-being-married function is attributable to the common empirical finding that males will tend to marry early if they are in occupations with flat age-earnings profiles but late in occupations with rising age-earnings profiles. The effect of the per capita wealth variables on the marriage probabilities of young adult males would be expected to be positive because of the positive influence that these variables would have on the marginal productivities of labor and all types, and hence on the profitability of investments in children which are an important bi-product of marriage. On the other hand, these same variables might well have a negative influence on the marriage probabilities of female young adults because in societies in which daughters "marry out" the higher marginal productivity of labor of all types in such households would be expected to induce household heads to want to hold onto their daughters longer than would those with less wealth. The negative influence of C_q^{2f} in (V-2) is attributable to the same phenomenon.

All of the above influences would be conditional on the household structure including in particular the number of siblings of similar sex. For example, the larger the number of female siblings, the higher would be the probability of marriage for young adult females C^{2f}, because of their diminishing marginal productivity in household activities. Also, the influences of some of the other variables might well be expected to shift according to the size and structure of the household as indexed by E. For example, the importance of loyalty to parents living in extended households arranging marriages for their children might lead to some delay due to extra search time to detect loyalty and compatibility in a future wife for a son and may diminish both the negative influence of the first variable and the positive influence of the second variable in such households.

Finally, the value of the bride price (or its negative dowry price) is

specified as follows:

$$b^{2f} = b(\overset{+}{H^{2f}}, \overset{+}{\frac{W^f}{p^{ij}_{ij}} / \frac{W^m}{p^{ij}_{ij}}}, \overset{+}{\frac{c^{2m}_q}{c^{2f}_q}})$$

The bride price would be higher, the higher the human capital of the bride, the higher the wealth of her family's household relative to that of the household of her husband and the higher the age-specific probability of the male being married relative to that of the female. The latter variable is inversely related to the age differential between male and female at marriage, the idea being that a larger differential will imply a longer period of widowhood for the wife and hence a higher bride price or lower dowry price.

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III. An Empirical Formulation of the Model

In the previous section, an analytical framework for investigating the role of the "old age security" motive on fertility and for evaluating the influence on fertility of introducing a social insurance program has been presented. The objective of this section is to identify implications of the analytical framework which may be examined with household survey data. The underlying motivation for this study is the belief that much can be learned about the role of the "old age security" motive in fertility and the influence of introducing a social insurance program on fertility from household survey data.

In the analytical framework presented, the household constitutes the basic unit of analysis. However, all decisions are not made by the household or household head, but instead distinct sets of subgroups or individuals are responsible for distinct decisions. This approach not only allows for individuals within the household to have different preference orderings but it also requires that specific decisions such as fertility, marriage, household formation, and labor force participation be governed by the preferences of the same subgroup or individual in all households. To implement this approach, the analytical framework has been divided into five distinct sets of stages with each stage focused on a given set of household decisions.

Before proceeding with the empirical formulation, the fact that all variables specified in the model are not observable is considered. This discussion is in direct response to criticisms which have been previously raised and which undoubtedly will be raised again. There is no disagreement with statemenst that a number of conceptual variables are introduced in the analytical framework which are not observable under any circumstances. These conceptual variables include utility, rate of time preference, continuous variable for family structure, and the shadow price of an individual's time are just a few examples. There is also no disagreement

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with statements that information for other variables such as the value of non-monetized assets or output, the expenditures of households on specific items, and the allocation of time by specific activity will generally be of questionable reliability in household surveys although the information is or at least conceivably is available. However, there are certain variables such as the number of surviving children and the sex ratio of surviving children, the composition of the household given a consistent definition of the household, the income from agricultural goods sold in the market and the number of persons in the household who worked as wage earners, and the age of marriage and age differential between mates which are reported in a number of existing household surveys and which are considered to be reasonably reliable. This last type of variable is, of course, the focus of the empirical formulations considered.

What is the justification or purpose of presenting an analytical framework based on a number of unobserved variables? At the more practical level, the procedure leads to some empirically testable hypotheses and indicates the appropriate econometric procedures. The procedure also assists in the quest to understand the underlying processes motivating observable results of the processes. However, the actual test of the analytical framework presented is the extent to which it assists in furthering an understanding of the "old-age security" motive and the influence the introduction of social security will have on fertility.

Suggestions of Empirical Formulation:

The discussion of the empirical formulation will proceed by stage and will include a brief summary of the stage under consideration and a description of the types of equations which may be estimated with household survey data. The specific estimation procedures will not be discussed except to note that the interdependencies between the stages will call for the use of two stage least squares as well as other estimation procedures designed to handle the cases of selectivity bias and

dummy endogenous variables.

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Stage I. Surviving Children

The first stage of the model is concerned with modeling the number of births and the probability of infant mortality for individual women. The representative women in a given household is reviewed as determining the number of children and the number who survive subject to the constraints on the woman's resources. The model presented is focused on modeling the demand for children and thus leads to demand equations for the number of births and for the number of children surviving.

As suggested by the analytical framework, a number of factors are expected to influence the demand for births and surviving children. These factors include the education level of the women and thus the preferences of the women for children, the knowledge of and acceptance of birth control practices, and the shadow price of time allocated to the various activities. Additional factors include the structure of the household, the type of agriculture and other determinants of the shadow price of children's and adults' time, and the age differential between husband and wife as an indicator of the need for children to provide old age support.

Stage II: Household Structures and Intergenerational Transfers

The second stage of the model is concerned with modeling the structure of households with special emphasis on the relationship between intergenerational transfers and household structures. The model is developed under the supposition that an optimal household structure exists. The analytical framework suggests that this optimal household structure is dependent on cultural preferences, the influence of household structure on production and on the extent to which adults are able to develop a sense of obligation within their children by maintaining

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a close household structure.

The basic variable of the analytical framework, "intensity of household structure" is not observable. However, households may be classified by type of structure and individuals may be characterized by this type of household structure and by their relationship to the head of the household. Observable variables hypothesized to influence family structure include the types of agricultural crops grown and agricultural techniques used to culturate crops, the age, sex, marital status, and education of the individual, and the characteristics of the village such as the availability of credit and distance from markets and transportation networks.

Stage III. Allocation of the Household's Resources: Static

The third and fourth stages of the analytical framework are closely related and concerned with modeling the resource allocation problem for the household. In both stages, the household or household head is the decision maker, the objective is to maximize household utility, and the constraints are the result of limits on the households basic resources, time and assets, and of given technologies for agricultural and household production and for production of physical and human capital. In stage III, attention is focused on intratemporal allocation decisions with investment dacisions and capital stocks taken as given. In stage IV, emphasis is given to intertemporal decisions and specifically to investment decisions and to determinants of the profile of physical and capital stocks over the life cycle of the household.

The model presented as stage III result in derived demands for inputs to the agricultural and household production processes and in demands for inputs to the preference or utility function for the household. Given the demands for time allocated to agricultural and household production and for leisure time and the phy-

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sical constraint on time, the demand for time to the various activities also leads to a demand for time in paid work or labor supply. For persons not engaged in paid work, the model also suggests the determinants of the shadow wage. In addition to the demands for time, the model also results in derived demands for outside workers for agricultural production, for market goods as inputs to agricultural and household production, and for agricultural and non-agricultural consumption goods. For all of the inputs to utility, shadow prices are also results of the model. The model is also useful in allowing some consideration of the differences in the output of households classified by family structure.

In contrast to previous stages, a number of implications are derivable from this model. Of specific interest are estimates of the probability of working for specific types of individuals particularly women, estimates of the shadow wage for persons and specifically children not employed in paid labor, and estimates of demand based family equivalence scales. All of these relationships will be dependent on indicators of the demand for labor in the local area, on indicators of household responsibilities such as number of children and dependent adults, on indicators of human capital such as education and of physical capital such as availibility of irrigation systems, tractors, and improved land.

Stage IV. Allocation of the Household's Resources: Dynamics

As noted above, this stage of the model is closely related to the previous stage and is concerned with investment and savings decisions including investments in physical assets to be used as inputs in agricultural and household production, investment in human capital, and private savings. The critical factors in these decisions include the anticipated rate of return, the cost of the investment, and the rate of time preference on the part of the household. The anticipated rate of return depends on the expected marginal productsof physical assets in

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agricultural and household production, on the marginal products of a worker with a specified level of human capital (or marginal product of unit of human capital, and on the wage paid a unit of human capital by employers) and on the rate of time preference. The cost of the investment depends on the shadow prices of inputs including the value placed on time ond on goods used as inputs. In some instances, the cost may be prohibitive given the location of the village or the need for labor to produce consumption goods (i.e., food). The availability of close substitutes for investment goods such as children and social insurance also influences the benefits of the investment.

In many instances, investments in human capital as well as agricultural and household capital are difficult to observe. Education is one generally available indicator for human capital but this indicator does ignore quality considerations in most instances. Some aspects of agricultural and household capital are aobservable such as the number of tractors, the availability of irrigation, or the amount of land used to product vegetables for home consumption, however, many are not. Specification of equations determining the level of investment will draw heavily on the determinants of shadow prices for capital goods and human capital developed in previous section. Indicators of the cost of financing investments, of the expected return based on cropping patterns and wage patterns, and on the availability of substitutes such as credit markets (money lenders), children, and social insurance are of particular importance.

Stage V. The Marriage Decision

This stage of the model is concerned with the modeling of the marriage decision. Both the age distribution of first and subsequent marriages, and the comparison of the characteristics of the two mates are of interest. The model developed in the analytical framework recognizes that marriage implies that two decision makers

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decide to join together as a team for at least some purposes such as child raising in some societies. In the developing countries, the question as to who is the relevant decision maker - the household head, the parents of the prospective mates, or the individuals themselves.

In the model presented, the marriage is assumed to occur when both parties expect to gain from the transaction. The gains forthcoming to the individuals depends on initial levels of physical and human capital. These initial levels will influence the age at marriage and the correlations of the characteristics of the two mates.

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Summary:

As a summary of the above discussion, the dependent variables to be considered are listed by stage.

Stage I. Fertility Model

Number of live births
Number of surviving children

Stage II. Household Structure and Intergenerational Transfers

Household type
Household headship

Stage III. Allocation of Household Resources: Static Analysis

Value of goods consumed by type of good
Expenditures for purchased goods
Participation in labor force
Number of periods worked
Type of worker (Earner or Family)

Stage IV. Allocation of Household Resources: Dynamic Analysis

Gross investment in physical assets by type of asset
Net change in financial assets
Value of farm equipment
Value of total livestock
Educational qualifications of individuals
Number of children who attend school

Stage V. Marriage Model

Age at marriage
Differences in age of mates

As a general rule, determinants of these variables include characteristics of village such as availability of credit and distance from transportation networks, indicators of type of agriculture based on crops produced, use of tractors, ownership of livestock, and use of irrigation, and demographic characteristics of family.

Footnotes

5/ $L_t c_t^1 + L_{t-1} c_t^2 + K_{t+1} - K_t = L_t f\left(\frac{K_t}{L_t}\right)$

$$g = \frac{L_{t+1} - L_t}{L_t} = \frac{K_{t+1} - K_t}{K_t}$$

$$c_t^1 + \frac{L_{t-1}}{L_t} c_t^2 + \frac{K_{t+1} - K_t}{K_t} \frac{K_t}{L_t} = f(k)$$

$$\frac{L_t - L_{t-1}}{L_{t-1}} = g \qquad \frac{L_t}{L_{t-1}} = 1 + g$$

$$c_t^1 + \frac{1}{1+g} \cdot c_t^2 + gk = f(k)$$

6/ $u = u[f(k) - gk - \frac{c^2}{1+g}, c^2]$

$$\frac{\partial u}{\partial k} = \frac{\partial u}{\partial c_1}(f^1(k) - g) = 0$$

$$\frac{\partial u}{\partial c^2} = \frac{\partial u}{\partial c_1}\left(-\frac{1}{1+g}\right) + \frac{\partial u}{\partial c_2} = 0$$

$$f^1(h) = g$$

$$\frac{\partial u/\partial c_1}{\partial u/c_2} = 1 + g$$

7/ The problem is to:

$$\max u = u(c^1, c^2, E)$$

subject to

$$c^1 + \frac{c^2}{1+r} = f(k,E) - rk - \tau_1 - \tau_2(E,g_2) + (\beta_1 + \beta_2(E,g_2)) * \frac{1}{1+r} + \frac{A}{L_t}$$

The Lagrangian and first order conditions are:

$$L = u(c^1,c^2,E) - \lambda[c^1 + \frac{c^2}{1+r} - f(k,E) + rk + \tau_1 + \tau_2(E,g_2) - [\beta_1 + \beta_2(E,g_2)] \cdot \frac{1}{1+r} - \frac{A}{L_t}$$

$$\frac{\partial L}{\partial c^1} = \frac{\partial u}{\partial c^1} - \lambda = 0$$

$$\frac{\partial L}{\partial c^2} = \frac{\partial u}{\partial c^2} - \lambda \cdot \frac{1}{1+r} = 0$$

$$\frac{\partial L}{\partial k} = \lambda[\frac{\partial f}{\partial k} - r] = 0$$

$$\frac{\partial L}{\partial E} = \frac{\partial u}{\partial E} - \lambda[-\frac{\partial f}{\partial E} + \frac{\partial \tau_2}{\partial E} - \frac{\partial \beta_2}{\partial E} \frac{1}{1+r}] = 0$$

$$\frac{\partial L}{\partial k} = -[c^1 + \frac{c^2}{1+r} - f(k,E) + rk + \tau_1 + \tau_2(E,g_2) - [\beta_1 + \beta_2(E,g_2)] \frac{1}{1+r} - \frac{A}{L_t}] = 0$$

The first order conditions may be written as:

$$\frac{\partial u/\partial c^1}{\partial u/\partial c^2} = 1 + r$$

$$\frac{\partial f}{\partial k} = r$$

$$\frac{\partial u}{\partial E} = \frac{\partial u}{\partial c^1}\left[-\frac{\partial f}{\partial E} + \frac{\partial \tau_2}{\partial E} - \frac{1}{1+r}\frac{\partial \beta_2}{\partial E}\right]$$

$$c^1 + \frac{c^2}{1+r} = f(k,E) - rk - \tau_1 - \tau_2(E,g_2) + \frac{1}{1+r}[\beta_1 + \beta_2(E,g_2)] + \frac{A}{L_t}$$

A fifth relationship which states the equality of saving with growth of system's private capital is:

$$f(k,E) - rk - \tau_1 - \tau_2(E,g_2) - c^1 - \frac{c^2}{1+r} + \frac{[\beta_1+\beta_2(E,g^2)]}{1+r} + \frac{A}{L_t}$$

$$= (k - k^s)(1 + g_2)$$

From the budget identity:

$$[\beta_1 + \beta_2(E,g_2)]/(1+g_2) \equiv \tau_1 + \tau_2(E,g_2) + k^s(r - g_2) + \frac{A}{L_t}$$

and the fourth and fifth equations may be rewritten as:

$$c^1 + \frac{c^2}{1+r} = f(k,E) - rk - \tau_1 - \tau_2(E,g_2) + (1+r)^{-1}(1+g_2)[\tau_1 + \tau_2(E,g_2) + k^s(r-g_2) + \frac{A}{L_t}] + \frac{A}{L_t}$$

and

$$\frac{c^2}{1+r} + (1+r)^{-1}(1+g_2)[\tau_1 + \tau_2(E,g_2) + k^s(r-g_2) + \frac{A}{L_t}] = (k - k^s)(1+g_2)$$

8/ There are, of course, difficulties in the identification of family members stemming in large part from the arbitrary line that must be drawn as to who is and who is not included in the family.

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