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MODELING INTRAFAMILIAL LINKAGES AND INTERGENERATIONAL TRANSFERS: IMPLICATIONS FOR DEVELOPMENT

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I. Introduction

The purpose of this paper is to demonstrate that intrafamilial linkages and intergenerational transfers impinge on economic development in general, and on the evolution of markets and the formation of human capital in particular. The paper consists of two parts (and two models). The first part draws on the following idea. Suppose that individuals who are family members are altruistically linked. This link can be shown to motivate transfers that do not arise in the absence of an altruistic link. If such transfers are more valuable to individuals than market transfers, markets may not evolve or, if they already exist, they may not be active. The connection between development of markets and economic development may break down.

The second part of the paper explores another transfer-related issue: Family members engage not only in atemporal "horizontal" transfers but also in intertemporal "vertical" transfers. In particular, parents transfer to their offspring(s) the family's productive resource - land. Typically, this transfer takes place upon the death of the parents. Therefore, the life expectancy of the parents impinges on the timing of the intergenerational transfer. The second part of the paper draws on the idea that this timing affects the human capital investment decisions of individuals: If the parental transfer takes place late in life, individuals tend to invest more in human capital formation than if the transfer takes place early in life. A productivity implication arising from the human capital formation behavior is that the (economy-wide) per-capita income is higher when parental life expectancy is longer.

A larger share of transfers and exchanges being relegated to the marketplace, and a higher level of human capital per capita, are usually taken as correlates of economic development, indeed, as causes of it. However, what

the paper demonstrates is that the nature and the timing of transfers in the "family sector" adversely affect both the size of the market sector and the economy-wide level of human capital. It appears then that the structure of incentives individuals face, arising from them being members of families, rather than, or along with, the paucity of resources individuals command, constrains processes closely associated with development.

Section II models altruistically motivated transfers, while section III models the timing of the transfer of the familial productive asset. Each section is divided into three sub-sections: motivation; a formal model and its main results; and conclusions.

II. Intrafamilial Altruism and Nonmarket Transfers

II. 1. Motivation

In all economies, but particularly in less developed countries, a considerable proportion of resource transfers takes place outside the realm of the marketplace: inside families, within households, and among members of kin group or caste. Often it is not all that clear what exactly these transfers "buy": we do not see commodities moving in the reverse direction nor do we observe a flow of easily definable services. For example, households in rural India "purchase" insurance against variability in consumption not from insurance companies but from other households whose sons marry their daughters, and whose incomes exhibit low covariability with their own (Rosenzweig and Stark (1989)). Such actions are different from typical marketplace exchanges where the transfer of a commodity from A to B is accompanied by the transfer of another commodity from B to A and where one of

the exchangeables is money, so that it is quite clear what is being bought - and at what price. It is generally argued that nonmarket intra-group transfers are mandated by the insufficient development of markets and that as development proceeds, a larger share of transfers and exchanges is relegated to the marketplace. This reassignment is believed to hasten the pace of economic development as the scope for exchange and trading opportunities increases. This, in turn, should feed back into the production opportunities set by facilitating increased specialization and recourse to comparative advantage.

The precise mechanisms that generate nonmarket transfers are not too well explored. This section reviews the role of intragroup altruism as one force leading to nonmarket transfers. If individuals receive altruistically motivated transfers which, in a sense to be made precise, are more valuable to them than market transfers, then the preference for interaction between altruistically connected individuals will not be wiped out as the economy becomes more market oriented. However, it is probably inappropriate to view altruism as a static force, ignoring the possibility of those events or actions that lead to its rise or fall (Stark (1989)). Thus, if the overall effect of enhanced altruism on a social group is positive, the group is more likely to foster it. In this case the practices based upon it will be more persistent than if the effect is negative. This variation might help explain the different transition rates to transfer regimes that are governed by full market forces.

Suppose that altruism is not invariant to conduct and actions, and that an activity which nurtures altruism precludes engagement in a beneficial market activity. Markets will not develop if the net transfer value arising

from the altruism-enhancing (or altruism-preserving) activity is larger than the net value due to the market activity. Moreover, the introduction of markets could crowd out altruistically motivated actions to such an extent that the group concerned may be worse off. Commercialization of blood-giving in the United States may explain why the amount of blood given voluntarily in that country is small and the total (per capita) supply of blood significantly less than in the United Kingdom where giving blood is completely voluntary and unpaid. (It is as if individuals cease to give blood when they see that other people are being paid for it. See Titmuss (1971) and Arrow (1974).)

The present section does not attempt to fully explain how an economy governed by altruistically motivated transfers transforms into a market-transfers economy. But it does contribute to understanding why such a transition may or may not take place. The section draws on the notion that when as an opportunity to trade anonymously a market entails transaction costs that are absent from an altruistically based transfer regime, the market will be "missing" or inactive.

II. 2. The Model

We formulate a fairly general model of preferences for family members. We focus on situations involving two individuals, F and S (father and son), although the principles discussed here can be generalized to larger groupings and other settings (such as generations of individuals who care about their own felicity as well as the utility of the parent generation and the succeeding generation).

Let C denote corn, the only good consumed, the total amount of which is

fixed arbitrarily. Suppose all this corn is initially under the father's control. The level of corn consumed by an individual affects his pleasure. We refer to this direct pleasure as "felicity" and describe it by functions $V_F(C_F)>0$, $V_S(C_S)>0$, $C>0$, $V_F'(C_F)>0$, $V_S'(C_S)>0$, where C_F is the consumption of corn by father and C_S is the consumption of corn by son. Each individual cares about his own felicity and the utility of the other. Assuming that each individual likes to consume corn (own felicity) and wants the other to be happy, utility is given by the following two simultaneous functions:

$$U_F(C_F,C_S) = (1-\beta_F)V_F(C_F) + \beta_F U_S(C_S,C_F) \tag{1}$$

$$U_S(C_S,C_F) = (1-\beta_S)V_S(C_S) + \beta_S U_F(C_F,C_S) \tag{2}$$

We have parameterized altruism by a simple scalar β_i - the weight that one places on the utility of the other relative to one's own felicity. We assume that $0<\beta_i<1$, that is, i attaches a non-negative weight both to his own felicity and to the other's utility; he is neither a masochist nor envious. To flesh out the implication of utility interdependence for preferences over consumption allocations we can solve (1) and (2) in terms of $V_F(C_F)$ and $V_S(C_S)$. This yields:

$$U_F(C_F,C_S) = (1-\alpha_F)V_F(C_F) + \alpha_F V_S(C_S) \tag{3}$$

$$U_S(C_S,C_F) = (1-\alpha_S)V_S(C_S) + \alpha_S V_F(C_F) \tag{4}$$

where $$\alpha_F = \frac{\beta_F(1-\beta_S)}{1-\beta_F\beta_S} \tag{5}$$

and $$\alpha_S = \frac{\beta_S(1-\beta_F)}{1-\beta_F\beta_S} \tag{6}$$

Note that from the restrictions on β_i in the fundamental specification, it follows that $\alpha_i>0$ <u>and</u> also, as can easily be verified, that $\alpha_F + \alpha_S<1$.[1]

For analytic simplicity we suppose for now - but see below on generalization to other functional forms - that

$$V_F(C_F) = \ln(C_F) \tag{7}$$

and that

$$V_S(C_S) = \ln(\mu C_S) \tag{8}$$

where $\mu>0$. Since

$$C_F + C_S = C \tag{9}$$

we can solve for the optimal level of the father's consumption of corn by differentiating (3) with respect to the single variable C_F.

This yields

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[1]If one <u>begins</u> with equations (3) and (4) rather than with equations (1) and (2) then there is no apparent reason to impose the restriction that $\alpha_F + \alpha_S <1$. When $\alpha_F + \alpha_S >1$, F and S will have disagreements in which each wants the other to accept a larger share of the communal corn. We ignore such a case for two reasons. First, it strikes us as more natural to take (1) and (2) as the fundamental specification of preferences rather than (3) and (4). While individuals may be able to observe each other's levels of happiness, they certainly cannot apprehend each other's felicity directly. That $\alpha_F + \alpha_S <1$ then follows from the absence of envy and masochism in the fundamental specification. Second, if one wishes to consider cases in which $\alpha_F + \alpha_S >1$ then one can simply think of individual F (S) as S (F). When an individual cares more about another person than about himself, then the individual is essentially the other so the two can simply be renamed. Our results then refer to questions such as what happens (for instance, to economic performance) as altruism falls from excessive levels.

$$\frac{dU_F(C_F,C_S)}{dC_F} = \frac{d}{dC_F}\left[(1-\alpha_F)\ln C_F+\alpha_F\ln(\mu(C-C_F))\right]$$

$$= \frac{1-\alpha_F}{C_F} - \frac{\mu\alpha_F}{\mu(C-C_F)}$$

From the first order condition we thus obtain

$$\left(\frac{C_F}{C_S}\right)_F = \frac{1-\alpha_F}{\alpha_F} \tag{10}$$

where the subscript F indicates that this is the optimal consumption ratio arising from the father's optimization.

In a similar way we can derive the consumption ratio which is optimal from the son's point of view:

$$\left(\frac{C_F}{C_S}\right)_S = \frac{\alpha_S}{1-\alpha_S} \tag{11}$$

From inspection of (10) and (11) it follows that

$$\left(\frac{C_F}{C_S}\right)_F > \left(\frac{C_F}{C_S}\right)_S \Leftrightarrow \frac{1-\alpha_F}{\alpha_F} > \frac{\alpha_S}{1-\alpha_S} \Leftrightarrow \alpha_F+\alpha_S<1 \ ; \tag{12}$$

since the R.H.S. inequality indeed holds, we conclude that the father's optimal allocation is such that he wishes to consume a larger proportion of corn than his son wishes him to consume. However, this does not necessarily imply a conflict. In Figure 1, point B represents the father's preferred ratio whereas point A represents the son's preferred ratio. To be sure, if the prevailing allocation is anywhere between O and A, that is, the son receives more than his preferred ratio while the father receives less than his preferred ratio, both father and son would favor the transfer of corn from son to father. If the existing allocation is anywhere to the right of B, both

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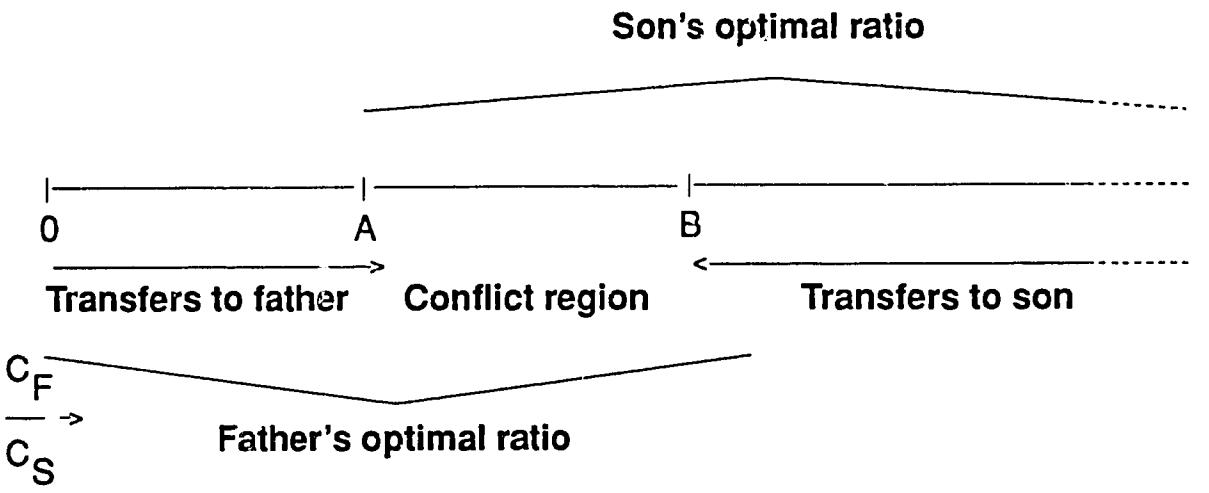

Figure 1 Optimal consumption ratios

parties will favor transfer of corn from father to son. However, should the initial allocation lie anywhere between A and B, there will not be blissful unanimity: a conflict will arise as the father would like to move right toward B, whereas the son would like to move left toward A.

Several implications can now be drawn. First, mutual altruism intersected with certain initial allocations of the consumption good results in mutually agreeable transfers; individuals who are altruistically linked can expect automatic (negotiation-free or conflict-free) transfers should the initial allocation be unfavorable to them (in the sense of falling outside AB). It is this feature of "guaranteed" transfers that accounts for the strong attraction of being associated with a kinship network even if anonymous markets exist. Note in particular that if father and son happen to experience an initial ratio to the left of A (a consensus for reallocation in favor of the father), it is immaterial who decides how to divide consumption; whether the son controls the stock of corn - in which case he will transfer corn to the father - or the father does - in which case he will retain the corn.

Second, although the presence of altruism narrows the domain of conflict (in the absence of altruism $\beta_F = \beta_S = 0$ - each party would like to consume the entire supply of corn leaving zero quantity to the other party) it does not eradicate it. The result that altruism does not necessarily eliminate conflicts about consumption allocations is clearly true in a model of one-sided altruism - for example, in a model where a parent's utility depends on own consumption, the number of children, and the utility attained by each child, and where the parent spends his earnings and inheritance on own consumption, on bequests to children, and on costs of raising children. It is not too difficult to show that in this setup, optimization by the parent could

result in a conflict with the children who want larger bequests than the parent is willing to give. (Barro and Becker (1989)). But what is a bit more revealing is that two-sided (mutual) altruism does not necessarily eliminate conflicts over allocations either.

Third, suppose the father's altruism toward his son rises. How will the distribution of corn be affected by such an increase? Put differently, what happens to consumption choices when the father becomes "more loving"? Given the interdependence of the utility functions, the answer to this question is not obvious. We know that β_F, the relative weight the father attaches to the utility of his son, reflects the intensity of his altruism. Thus, we need examine the sign of a change in the optimal ratio with respect to a change in β_F. We obtain

$$\frac{\partial\left(\frac{C_F}{C_S}\right)_F}{\partial\beta_F} = \frac{-\frac{d\alpha_F}{d\beta_F}}{\alpha_F^{\,2}} < 0 \tag{13}$$

with the inequality sign arising from $\frac{d\alpha_F}{d\beta_F} > 0$ as can be verified by inspection of (5). Thus, if the son succeeds in raising his father's altruism toward him, B in Figure 1 shifts to the left so that, for example, more initial allocations result in conflict-free transfers from father to son. Note, however, that although the conflict range is declining in the intensity of the father's altruism toward his son, it is not wiped out (that is, as long as $\alpha_F + \alpha_S < 1$).

Fourth, suppose that a bumper crop (or, in another context, a public transfer) raises the quantity of corn available for distribution and consumption. How would transfers be affected? Since constraint (9) would now

merely change to $C_F + C_S = kC$ $k>1$, optimization will result in (10) and (11) as before. Hence, (12) continues to hold and A and B in Figure 1 do not shift. (Indeed, for the chosen logarithmic specification of the utility functions, the preferred point B has both father's and son's consumptions rise in exactly the same proportion as the family's total corn. And likewise with regard to preferred point A.) Potential conflicts over consumption allocations are not a declining function of the total quantity of the consumption good. It appears then, not surprisingly, that the son's route to higher utility is a larger quantity of C available for total consumption - regardless of how this greater quantity is distributed (inspect (4)) - or a stronger father's altruism. However, only the latter can secure a distribution which is at once conflict-free <u>and</u> more favorable.

Suppose (7) and (8) are replaced by

$$V_F(C_F) = \gamma C_F^{\gamma} \tag{7'}$$

and

$$V_S(C_S) = \gamma C_S^{\gamma} \tag{8'}$$

for any $\gamma<1$. The analysis as per equations (9) through (12) follows through as before, except that the optimal consumption ratios now appear as

$$\left(\frac{\tilde{C}_F}{\tilde{C}_S}\right)_F = \frac{1-\alpha_F}{\alpha_F} \tag{10'}$$

and

$$\left(\frac{\tilde{C}_F}{\tilde{C}_S}\right)_S = \frac{\alpha_S}{1-\alpha_S} \tag{11'}$$

where $\tilde{C}_F = C_F^{1-\gamma}$ and $\tilde{C}_S = C_S^{1-\gamma}$. From inspection of (10') and (11') it follows that $\left(\frac{\tilde{C}_F}{\tilde{C}_S}\right)_F > \left(\frac{\tilde{C}_F}{\tilde{C}_S}\right)_S \iff \alpha_F+\alpha_S<1$ which brings us back to Figure 1, except that

$\frac{\tilde{C}_F}{\tilde{C}_S}$ substitutes for $\frac{C_F}{C_S}$.

Two remarks are in order. First, the preceding four results are not specific to logarithmic utility functions. They hold under an alternative (exponential) specification of the utility function. Indeed, the results arising from using logarithmic or exponential utility functions are due to these specifications representing homothetic utility functions over allocations.

Second, it is of interest to see whether the result pertaining to the increase in the family's corn is general. It turns out that as long as $V_F(C_F)$ and $V_S(C_S)$ are strictly concave functions, an increase in the family's corn results in the father's preferred allocation having greater consumption both for himself and for his son. A symmetric statement applies to the son. When preferences are additively separable and the consumption functions are strictly concave, <u>all</u> goods are normal goods and therefore, a larger quantity of C, regardless of its distribution, is sure to raise the son's utility (see Becker (1974)).

II. 3. Conclusions

We have examined altruistically motivated consumption transfers as part of an effort to account for nonmarket transfers. We have seen that altruistic linkages lead to autonomous, negotiation-free transfers, and that such transfers respond positively to stronger altruism. The demonstration that altruism reduces transaction costs may be seen as a rationale for the persistence of nonmarket transfers. But we have also seen that given our

quite natural assumptions concerning the altruism parameters, a rise of altruism narrows the conflict range, even though such a rise does not necessarily result in group (social) harmony. To the extent that altruism is a family-specific asset, the benefits arising from altruistic linkages and from a rise in altruism will be forfeited upon transacting in the marketplace. It then stands to reason that the more valuable these benefits are, the less likely it is that markets will evolve.

III. The Timing of Intergenerational Transfers, Human Capital Formation, and Per-Capita Income

III. 1. Motivation

A fairly strong positive association exists between per-capita income and life expectancy across developing countries.[2] Even though associations do not reveal causality, in this case one explanation of the association is transparent as the association itself: countries that master means and resources to provide more higher-quality health and health-related services have longer-lived residents. The possibility that causality runs in exactly the opposite direction, that is, that longer life expectancy translates into higher per-capita income is less well recognized. This possibility is taken up in the current section. Specifically, we study the chain that longer life expectancy encourages larger investments in human capital which in turn facilitates the attainment of higher income per capita. Although in itself

[2]For a group of 75 developing countries in 1989 (World Bank (1991)) the Pearson correlation coefficient between life expectancy and income per capita is 0.7421. The coefficient for the same countries in 1977 (World Bank (1979)) is 0.7567. The change is not significantly different from zero (using conventional levels of significance).

this chain is not novel, the proposed microeconomic rationale which underlies the observed macroeconomic relationship is novel.

When education and skills are more abundant, countries produce more. Although the close link between investment in human capital, per capita income, and growth is well documented (e.g., Uzawa (1965), Lucas (1988), Romer (1989), Galor and Zeira (1989), Azariadis and Drazen (1990), Ehrlich and Lui (1991), Mankiw, Romer, and Weil (1992) and Tsiddon (1992)) the underlying mechanism is not yet fully understood. Recently, Becker, Murphy and Tamura (1990) suggested an explanation that draws on the role of fertility behavior: higher fertility is assumed to raise the rate of discount in the intertemporal utility function, thereby discouraging investment in human capital. Just as changes in fertility behavior modify the incentive structure that impinges on investment behavior, holding life expectancy constant, according to our approach changes in life expectancy account for changes in human capital investment, holding fertility behavior constant.

To illustrate how different life expectancies bring about different levels of investment in human capital, consider a world where assets are fully transferred through bequests. If life expectancy is 40, and if a child is capable of making productive use of familial assets at the age of 20, then bequests occur exactly when the child is ready to receive and make productive use of assets, assuming the parent was 20 when the child was born. However, if life expectancy is 70, then, retaining other assumption as above, the child must wait 30 years to receive familial assets. The incentive then for the child, to invest in the acquisition of human capital would be greater, provided that both forms of capital income enhance earnings.

The links between life expectancy and per-capita income, on the one

hand, and per-capita income and human capital, on the other hand, however modeled, do not convert easily into a causal relationship between life expectancy, human capital formation, and per-capita income.[3] In this section we offer a microeconomic-based model that provides such a relationship - to our knowledge, for the first time. Specifically, we demonstrate that in an economy where life expectancy is long and the transfer to offspring of the familial productive resource - land - takes place late in life, individuals invest more in human capital formation than if life expectancy is short and the parental transfer takes place early in life. Since the timing of the transfer is not known with certainty, a decision to invest in human capital formation must factor in the possibility that acquired human capital will not be used or that it will be used only a little. That is, if the earnings arising from combining labor with a productive physical asset - land - are higher than the earnings arising from assetless application of labor amplified by human capital, the individual will switch from the latter to the former engagement, and this possible shift has to be considered in deciding to acquire human capital. We develop the model to show that the productivity implications arising from the human capital formation are such that (economy-wide) per-capita income is higher when parental life expectancy is longer.

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[3]It is of interest to note that the "Basic Indicators" table in the World Development Reports of the World Bank provides data on only three measures of development: Per-capita income, life expectancy, and adult literacy - a measure of human capital.

III. 2. The Model

Consider an overlapping-generations economy in which economic activity is conducted over infinite discrete time. In every period t, t=0,1,2,..., the economy produces a single good in two sectors: a nonfarm sector in which the production technology requires efficiency units of labor, and a farm sector that uses land and physical units of labor in the production process.

III. 2.1 Production

III. 2.1.1 The Nonfarm Sector

Production in the nonfarm sector occurs within a period according to a constant returns to scale, production technology which is stationary across time. The output of the nonfarm sector produced at time t, Y_t^{nf} , is

$$Y_t^{nf} = f(L_t) = L_t f(1), \tag{14}$$

where L_t is the quantity of labor, measured in efficiency units, employed at time t. The production function f: $R_+ \to R_+$ is twice continuously differentiable, $f'(L_t)>0$ and $f''(L_t) = 0$ $\forall L_t \geq 0$, and $f(0) = 0$. The market for efficiency units of labor is perfectly competitive. Given constant returns to scale in production the wage rate per efficiency unit of labor is therefore stationary at a level $\bar{w}$, where

$$\bar{w} = f'(L_t) = f(1). \tag{15}$$

III. 2.1.2 The Farm Sector

Production in the farm sector occurs within a period and allows individuals who own a unit of land to combine it with their physical unit of labor to produce $\bar{y}$ units of output (regardless of the number of efficiency

units embodied in this unit of physical labor).[4] The marginal productivity of an additional unit of labor is lower than that in the nonfarm sector. Furthermore, land changes hands only through intra-familial, intergenerational transfers.

III. 2.2 Consumption and Investment in Human Capital

In every period t a generation is born. A generation consists of a continuum of individuals of measure N.[5] Each member of generation t has a single parent in generation t-1 and each parent of generation t-1 has a single offspring in generation t. The economy consists, therefore, of a continuum of dynasties of measure N. Each dynasty is endowed with a unit of land that is transferred across generations. By the existing social code land is transferred from parent to child upon the death of the parent.

The duration of life is uncertain. Individuals may live either two or three periods. They face a probability $\alpha \in [0,1]$ of dying at the end of the second period. If they survive, with probability of $(1-\alpha)$, they die at the end of the third period. Population size is thus $N + N + N(1-\alpha) = N(3-\alpha)$.

Individuals of generation t are characterized by their intertemporal utility function defined over consumption in the three periods of their life

$$U^t = \sum_{i=1}^{3} \beta^{i-1} u(c_i^t), \tag{16}$$

where $\beta<1$ is the individual's discount factor and

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[4]This simplification is not essential for our results; we can allow for $\tilde{y}$ to be somewhat sensitive to coupling with human capital. For four developing countries for which comparable evidence is available, the effect of an additional year of schooling on both wages and farm output is positive, although the percentage increase in wages is 3 to 5 2/3 times the percentage increase in farm output, with the former being as high as 17 percent (World Bank (1991), Table 3.2).

[5]For simplicity, there is no population growth. The qualitative nature of the analysis will not be affected by allowing nonzero population growth.

$$u'(c)>0 \text{ and } u''(c)\leq 0 \ \forall c\geq 0;\ u(0)>-\infty \tag{17}$$

Thus, $u: R_+ \to R_+$ is strictly monotonic increasing, concave and bounded from below. Furthermore, it satisfies the expected utility axioms.

In the first period of their lifetime (youth), individuals of generation t are endowed with a unit of labor but with no land. Individuals allocate their unit endowment of labor between work in the nonfarm sector at the competitive market wage $\bar{w}$ and investment in human capital. Given the absence of capital markets or the availability of storage technology, individuals consume their entire wage income in the first period. Thus, the first period consumption of a member of generation t is $c_1^t = \bar{w}\,\ell$, where $\ell \in [0,1]$ is the proportion of the unit endowment of labor that an individual chooses to allocate to work, and $(1-\ell)$ is therefore the proportion allocated to investment in human capital. The amount of human capital, h, (measured in efficiency units of labor that are available for usage in the second period of the individual's lifetime) generated by this level of investment in human capital is

$$h = \phi(1-\ell) \tag{18}$$

where

$$\phi(0) = 1,\ \phi(1-\ell)>1,\ \phi'(1-\ell)>0 \text{ and } \phi''(1-\ell)<0,\ \forall \ell \in (0,1) \tag{19}$$

Thus, if investment in human capital does not take place (that is, $(1-\ell) = 0$) the number of efficiency units available for the individual in the second period is equal to the initial endowment of 1. Otherwise, the number of efficiency units available in the second period is increasing in the level of

investment in human capital, but at a decreasing rate.[6] Furthermore,

$$\lim_{\ell \to 1} \phi'(1-\ell) = \infty \quad \text{and} \quad \lim_{\ell \to 0} \phi'(1-\ell) = 0. \tag{20}$$

In the second period of their lifetime (middle age) individuals of generation t are endowed with $\phi(1-\ell)$ efficiency units of labor, and with probability $\alpha \in [0,1)$ (i.e., in case of a parent's death at the end of the second period of the parent's lifetime) with a unit of land. If the parent does not die and consequently no land inheritance is obtained, individuals supply inelastically their efficiency units of labor, generating a wage income of $\bar{w}\,\phi(1-\ell)$. This wage income is subsequently consumed. However, if the parent does die, the individual inherits a unit of land. Individuals, therefore, may utilize the technology which combines a unit of land and a physical unit of labor to produce $\bar{y}$ units of output. Since transfer of the property rights to land is not allowed, this technology will be employed as long as $\bar{y} > \bar{w}\,\phi(1-\ell)$.[7] Suppose that this inequality indeed holds and that the distribution of earnings is fairly compact, that is,

$$\bar{y} = \bar{w}\,\phi(1-\ell)+e, \tag{21}$$

where $e>0$ is sufficiently small. It follows that regardless of the level of investment in human capital individuals who inherit land find it beneficial to utilize the traditional technology and to produce $\bar{y}$ units of output which is subsequently consumed. Thus, the second period consumption of an individual of generation t, c_2^t, is

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[6]Direct outlays in connection with human capital investment are disregarded. The investment costs consist only of forgone earnings.

[7]The qualitative nature of the analysis will not be affected if the land can be rented as long as $\bar{y} > \bar{w}\,\phi(1-\ell)$ + land rent, namely, as long as the owner of the land is significantly more productive than potential renters in cultivating the land. Rosenzweig and Wolpin (1985) provide strong evidence that such productivity differentials do exist.

$$c_2^t = \begin{cases} \bar{w}\,\phi(1-\ell) & \text{with probability } 1-\alpha \\ \bar{y} & \text{with probability } \alpha \end{cases} \tag{22}$$

Individuals reach the third period of their lifetime with probability $(1-\alpha)$. At that time they are endowed with a unit of land (inherited from the deceased parent) and with $\phi(1-\ell)$ efficiency units of labor. Given (21), individuals in this case employ the traditional technology which generates $\bar{y}$ units of output that is subsequently consumed. Thus, $c_3^t = \bar{y}$.

Individuals allocate their first-period endowment of labor between work and investment in human capital so as to maximize their expected utility from consumption. Thus,

$$\ell(\alpha) = \text{argmax}\{u(\bar{w}\,\ell) + \beta\{(1-\alpha)u[\bar{w}\,\phi(1-\ell)] + \alpha u(\bar{y})\} + \beta^2(1-\alpha)u(\bar{y})\}. \tag{23}$$

Given the properties of the ϕ function as stated in (19) and (20), and since $\alpha \in [0,1]$, the solution to (23) is interior (that is, the level of investment in human capital $(1-\ell) \in (0,1)$) and is given by the first-order condition

$$(1-\alpha)\phi'(1-\ell) = \frac{u'(\bar{w}\,\ell)}{\beta u'[\bar{w}\,\phi(1-\ell)]}. \tag{24}$$

Lemma 1 *Under (17), (19), and (20), an increase in the parent's life expectancy increases the investment in human capital by the child (i.e., $\partial(1-\ell)/\partial(1-\alpha) > 0 \;\; \forall \ell \in (0,1)$).*

Proof: See Appendix.

III. 2.3 Stationary Output

In every period t, each young individual supplies ℓ efficiency units of labor to the nonfarm sector. In addition, with probability $(1-\alpha)$, each middle-aged individual supplies $\phi(1-\ell)$ efficiency units of labor. Thus, the aggregate supply of labor to the nonfarm sector in efficiency units, L_t, is

$$L_t = [\ell + (1-\alpha)\phi(1-\ell)]N. \tag{25}$$

Given (14), the output produced in the nonfarm sector is $Y_t^{nf} = L_t f(1)$. The output produced in the farm sector at time t is $Y_t^f = \bar{y}N$. The aggregate output produced in the economy at time t, Y_t, is therefore stationary at a level $\hat{Y}$, where

$$\hat{Y} = \hat{Y}^{nf} + \hat{Y}^f = \{[\ell+(1-\alpha)\phi(1-\ell)]f(1)+\bar{y}\}N. \tag{26}$$

Given that the population size is $(3-\alpha)N$, the per-capita aggregate output, $\hat{y}$, is

$$\hat{y} = \frac{[\ell+(1-\alpha)\phi(1-\ell)]f(1)+\bar{y}}{3-\alpha}. \tag{27}$$

Thus, the following results can be derived:

Proposition. *Under (17), (19) - (21), an increase in life expectancy increases the stationary per-capita output in the economy (i.e., $\partial\hat{y}/\partial(1-\alpha)>0$).*

Proof: See Appendix.

Corollary. *Consider a world that consists of countries which are identical in all respects except for the life expectancy of their populations. Under (17), (19) - (21), the per-capita income is higher in countries in which life expectancy is higher.*

As follows from (26), (27) and (A2), aggregate as well as per-capita output in the nonfarm sector increase with life expectancy. The aggregate output in the farm sector is constant, however, given the constant supply of land. Furthermore, since an increase in life expectancy increases the number of individuals in the economy at any point in time, in per-capita terms the output in the farm sector decreases with life expectancy. Thus, the propositions hold as long as the increase in the per-capita output in the nonfarm sector outweighs the decrease in the per-capita output in the farm

sector. As follows from (A2), if (21) is not satisfied the propositions are less likely to hold the larger the share of farm output in total output.

III. 3. Conclusions

Human capital theory predicts that, holding all else constant, a longer life expectancy encourages individuals to invest more in human capital formation because of the prolongation of the payoff period. Our model expands the human capital framework to incorporate the case where the prolongation of life expectancy of cohort t induces more human capital formation by cohort t+1 because of the resulting postponement of the transfer of familial productive assets. We prove that as a consequence, per-capita income in the economy with the longer-lived generation t is higher.

The model expands the human capital framework in yet another way: the acquisition of human capital serves not only as a means of enhancing productivity but also as a form of insurance. In the event that land will not be transferred in the second period, earnings are guaranteed to be higher than those that would have accrued to bare labor.

The analysis helps explain a number of stylized facts. Several empirical studies point to absence of a trend toward equality across countries except among the subset of the very wealthy (Romer (1986), Lucas (1988), Barro and Sala-i-Martin (1992) and Dowrick (1992)). One reason for this nonconvergence could be that poor economies are locked in an incentive structure that operates to discourage human capital formation. And low levels of human capital formation translate into low levels of per-capita income. If human capital not only enhances the productivity of those who accumulate it but also confers *external* benefits on the productivity of others, economies that form large quantities of human capital will increasingly distance

themselves from economies that form small quantities. Income equality may not come about simply in the natural course of events. Our model thus predicts that as long as disparities in life expectancy across countries exist, disparities in the levels of per-capita income between countries will exist as well. Evidence suggesting that some convergence does occur (e.g., Barro (1991) and Mankiw, Romer and Weil (1992)) is not inconsistent with our model, however. If life expectancy is endogenized, then convergence in life expectancy *may* take place and lead, in conjunction with other factors, to convergence in per-capita income.

The model may hint at an interesting association between the behavior of parents, the well-being of their children, and social welfare. Especially if children cannot borrow against expected terminal assets, the timing of the transfer of parental wealth impinges not only on their behavior toward their parents but apparently also on allocative decisions. This, in turn, affects the children's own well-being, and hence the well-being of society. A social rationale for the postponement of the transfer of familial resources to the time of death - or very close to that time - may thus be that this pattern results in a higher per-capita output. Our model may then be read "inside out"; if a society were to adopt a rule of conduct as assumed, would it be better off in the long run in comparison to a society that pursues an alternative norm? The apparent advantage of postponing the timing of intergenerational transfers may explain the evolution and sustainability of a social code that so mandates.

In the 60's and 70's, the Moshav movement in Israel prohibited breaking up family plots. Consequently one child, usually the elder son, inherited the family farm. Whereas typically the heir-designate did not acquire a college

or a university degree, the other children did. For them, the low probability of receipt of the family land (an event which could have taken place had the elder son died prematurely) served as an inducement to acquire other earning-enhancing capital.

Our model gives rise to several testable predictions. One such prediction is that the parental life expectancy effect has a positive impact on the level of the investment in human capital undertaken by the children, an effect which is separate from the one arising from the prolongation of life of the children themselves (the children's life expectancy effect). The empirical difficulty here is that children who observe a higher life expectancy of their parents may infer that their own life expectancy would also be higher, so that their human capital investment decisions may be fully explained by the traditional human capital framework. To overcome this difficulty, though, we can think of a situation where the life expectancy of the parents rises while that of the children falls, yet human capital formation by the children is larger. Such an outcome can only arise from the operation of the parental life expectancy effect since the negative children's life expectancy effect implies reduced investment in human capital by the children. We can likewise think of a situation where the life expectancy of the parents falls, that of the children rises, yet investment in human capital by the children declines. Any one of these scenarios then could provide a discriminating test between our model and the traditional human capital model.

More concretely though, our model predicts that in a country such as India, where daughters do not inherit the family's land but sons do, a rising life expectancy of the parents - even if interpreted by the children as a signal that their own life expectancy will be higher - has a stronger effect

on human capital formation by boys (two effects are operative) than by girls. Furthermore, consider the case of societies characterized by "perfect primogeniture" - one child, the eldest, receives all the bequest. Since all other children are then immune to the timing of transfer their human capital investment behavior will not be sensitive to a change in the life expectancy of the parent. Thus, if the life expectancy of the parent rises then, again, even if all children were to infer that their own life expectancy will be higher, human capital investment by the eldest child will increase by more than will human capital investment by the other children.

The number of individuals who either engage in human capital formation or work in the nonfarm sector is an increasing function of life expectancy.[8] Suppose these activities are carried out in the urban economy. Then, a prediction of the model is that higher life expectancy is positively correlated with the proportion of the population residing off the farm.

Finally, the procedure employed in the construction of our model gives rise to the following testable prediction: the higher the share of the farm sector in total output, the smaller the impact of life expectancy on per-capita output.

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[8]Since N out of the $(3-\alpha)N$ members of the population are tilling the N farms, for the remainder $(2-\alpha)N$, $\partial[(2-\alpha)N]/\partial\alpha<0$.

APPENDIX

Proof of the Lemma. Using the implicit function theorem, it follows from (24) that

$$\frac{\partial \ell}{\partial \alpha} = \frac{-\beta u'[\bar{w}\ \phi(1-\ell)]\phi'(1-\ell)}{\bar{w}\ u''(\bar{w}\ \ell)+\beta(1-\alpha)\{u''[\bar{w}\ \phi(1-\ell)]\bar{w}\ [\phi'(1-\ell)]^2+u'[\bar{w}\ \phi(1-\ell)]\phi''(1-\ell)\}} \tag{A1}$$

Noting (17), (19) and (20), the lemma follows.

Proof of the Proposition. Using (26),

$$\frac{\partial \hat{y}}{\partial \alpha} = \frac{\{[1-(1-\alpha)\phi'(1-\ell)]\frac{\partial \ell}{\partial \alpha}\ -\phi(1-\ell)\}(3-\alpha)f(1)+\{[\ell+(1-\alpha)\phi(1-\ell)]f(1)+\bar{y}\}}{(3\ -\ \alpha)^2} \tag{A2}$$

$$= \frac{[1-(1-\alpha)\phi'(1-\ell)\frac{\partial \ell}{\partial \alpha}\ (3-\alpha)f(1)-[\phi(1-\ell)f(1)-\bar{y}\ ]-\phi(1-\ell)-\ell\ ]f(1)}{(3\ -\ \alpha)^2}.$$

As follows from (19) $\phi(1-\ell)>1>\ell\ \ \forall \ell \in (0,1)$. Furthermore, $(1-\alpha)\phi'(1-\ell)>1$ as follows from (24), (17) and (19), and $\phi(1-\ell)f(1)=\phi(1-\ell)\bar{w}=\bar{y}-\epsilon$, where $\epsilon>0$ is sufficiently small, as follows from (15) and (21). Thus, noting (A2) and Lemma 1, the proposition follows.

REFERENCES

Arrow, Kenneth J. 1974. "Gifts and Exchanges." Philosophy and Public Affairs 1: 343-362.

Azariadis, Costas, and Alan Drazen. 1990. "Threshold Externalities in Economic Development." Quarterly Journal of Economics 105: 501-526.

Barro, Robert J. 1991. "Economic Growth in a Cross-Section of Countries." Quarterly Journal of Economics 106: 407-444.

Barro, Robert J., and Gary S. Becker. 1989. "Fertility Choice in a Model of Economic Growth." Econometrica 57: 481-501.

Barro, Robert J. and Xavier Sala-i-Martin. 1992. "Convergence." Journal of Political Economy 100: 223-251.

Becker, Gary S. 1974. "A Theory of Social Interactions." Journal of Political Economy 82: 1063-1094.

Becker, Gary S., Kevin M. Murphy, and Robert Tamura. 1990. "Human Capital, Fertility, and Economic Growth." Journal of Political Economy 98: S12-S37.

Dowrick, Steve. 1992. "Technological Catch Up and Diverging Incomes: Patterns of Economic Growth 1960-88." The Economic Journal 102: 600-610.

Ehrlich, Isaac, and Francis T. Lui. 1991. "Intergenerational Trade, Longevity, and Economic Growth." Journal of Political Economy 99: 1029-1059.

Galor, Oded and Joseph Zeira. 1989. "Income Distribution and Macroeconomics." Brown University, Department of Economics, Working Paper Series, Paper No. 89-25.

Lucas, Robert E., Jr. 1988. "On the Mechanics of Economic Development." Journal of Monetary Economics 22: 3-42.

Mankiw, Gregory, David Romer, and David Weil. 1992. "A Contribution to the Empirics of Economic Growth." Quarterly Journal of Economics 107 (forthcoming).

Romer, Paul, M. 1986. "Increasing Returns and Long-Run Growth." Journal of Political Economy 94: 1002-1037.

_____. 1989. "Human Capital and Growth." National Bureau of Economic Research, Working Paper Series, Paper No. 3173 (November).

Rosenzweig, Mark R., and Oded Stark. 1989. "Consumption Smoothing, Migration

and Marriage: Evidence from Rural India." Journal of Political Economy 97: 905-926.

Rosenzweig, Mark R., and Kenneth I. Wolpin. 1985. "Specific Experience, Household Structure, and Intergenerational Transfers: Farm Family Land and Labor Arrangements in Developing Countries." Quarterly Journal of Economics 100(suppl.): 961-987.

Stark, Oded. 1989. "Altruism and the Quality of Life." American Economic Review (Papers and Proceedings) 79: 86-90.

Titmuss, Richard. 1971. The Gift Relationship: From Human Blood to Social Policy. (London: George Allyn and Unwin).

Tsiddon, Daniel. 1992. "A Moral Hazard Trap to Growth." International Economic Review 33: 299-322.

Uzawa, Hirofumi. 1965. "Optimum Technical Change in an Aggregative Model of Economic Growth." International Economic Review 6: 18-31.

World Bank. 1979. World Development Report 1979. New York: Oxford University Press.

World Bank. 1991. World Development Report 1991. New York: Oxford University Press.