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CENTER DISCUSSION PAPER NO. 317

AN ECONOMIC ANALYSIS OF THE EXTENDED FAMILY IN
A LESS DEVELOPED COUNTRY: THE DEMAND FOR THE ELDERLY
IN AN UNCERTAIN ENVIRONMENT

Mark R. Rosenzweig and Kenneth I. Wolpin

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I. Introduction

The kinship family is among the most ubiquitous of institutions to be found in human society. It is, therefore, natural to assume that living with kin is in general superior to residing in a single member household for most adult individuals. Despite its apparent universality, however, the family is far from homogeneous in terms of size and complexity across and within societies and may have altered significantly in structure over time. For example, in the World Ethnographic Sample (Murdock, 1957), which permits classification of 549 societies, 55 percent are typified by an extended family system, i.e, basically a family consisting of at least one kin member other than the husband, wife, and offspring, and 45 percent by a nuclear family system. Moreover, although the evidence is not conclusive, many societies seem to be moving in the direction of the nuclear family structure (Goode, 1963)¹. It is the purpose of this paper to examine theoretically and empirically one particular economic rationale for the extended family type most prevalent in developing countries, that characterized by households whose adult members are intergenerationally linked. Because adult offspring of similar age do not often reside in the same household in the absence of a parent, it would appear that any useful theory of the extended family must be founded on a presumption about the role of the elderly within the family.

Three distinct theories are to be found in the quite extensive sociological literature on family organization: the old-age security hypothesis and what could be termed the wealth transfer and the specific-experience hypotheses. The old-age security hypothesis views the extended

family as a means of providing for elderly members of the family, whose subsistence requirements exceed their household and market productivity. In the absence of a highly developed asset market, usually assumed in a less developed country context, children are thus the primary assets of the adult and the means of subsistence for the elderly generation. It is imperative within this framework however, that the younger generation be obligated in some way to make such transfers, since it would appear in their self-interest simply to withhold payments to the relatively unproductive elderly. An implicit contract must exist therefore between the generations ("norms") which can be enforced without the threat of sanction (Willis, 1979).

The wealth-transfer hypothesis focuses on the sanctions available to the elderly to encourage transfers and depends crucially upon family wealth ownership being vested in the elderly members. Given the existence of such asset control, it is necessary here, in contrast to the first hypothesis, to assume that there are services which can only be provided by offspring ("own" grandchildren) such that elders would want to trade off their current and future consumption that would be available from exhausting "family" wealth. Alternatively, the elderly may act as altruists who take into account the utility of all offspring if they command sufficient resources to mitigate the selfish tendencies of other family members, e.g., adult siblings (Becker, 1979).

In this paper we explore an alternative theory, which in contrast to the first two hypotheses, focuses on the unique productive characteristics of the elderly and requires no assumptions about capital markets, ownership of assets or the "uniqueness" of services provided by offspring. It assumes instead that elders, whatever their

average productivity, are differentially more productive than their adult offspring in a set of activities which require experientially obtained knowledge. If such knowledge contains a significant family-specific component (labor market substitutes are less than perfect), then the younger generation has some incentive to assume some of the current expenses of their elderly parents or in-laws in order to benefit from their accumulated wisdom.

The value of the elderly is particularly high in a world with unchanging technology, since the knowledge acquired by elders does not obsolesce with the passage of time, remaining equally useful from generation to generation. For example, the experience gained in raising own children is most valuable when applied to the next kinship generation, but only valuable at all if the environment has not itself been drastically transformed. Or, to take the example considered extensively in this paper, in a traditional agricultural setting with constant technology, the elderly can supply information about the most efficient techniques for coping with previously experienced varieties of adverse weather, techniques which are likely to have a farm-specific component. Clearly, in each of the two cases, as long as offspring accumulate household or farm-specific experience as well there is room for trade, though the equilibrium sharing ratio can not easily be determined without additional structure.²

While all three hypotheses can account for the existence of the intergenerationally-linked family, this paper is concerned with formulating more precise tests of the specific-experience hypothesis. We do so in the main because it is not readily apparent exactly what implications of a testable nature can be drawn from the alternative theories. We show

that the specific-experience hypothesis is capable of refutation. To this end we estimate in Section II the contribution to agricultural profits of farm-specific experience as embodied in elderly kin on farms experiencing deviations from "normal" weather conditions, utilizing a three-year panel of household data from India. In Section III a simple optimization model which highlights the essential features of the specific-experience theory within the context of an agrarian setting subject to uncertain weather is formulated and the comparative static implications are examined empirically based on Indian farm profit variability data and an inter-district time series of rainfall covering thirty years. The results indicate that the elderly have a significant productive advantage within static technology societies, such as India, in allocating resources under conditions less likely to have been experienced by the young. As a consequence, where expected farm profit variability is high due to historically observed rainfall variation, there are significantly greater concentrations of families extended across generations. The results also suggest the existence of a market for the skills characterizing the elderly in the Indian context. Section IV summarizes the results and discusses the implications of these findings for the relationship between family structure and economic development.

II. The Value of the Elderly in Agriculture

a. The Data and Specification

The fundamental notion underlying the specific-experience rationale for the existence of an intergenerationally-extended family is that the elderly have accumulated stocks of useful information or knowledge which are most valuable to offspring and which cannot be acquired by the latter

from other sources at less cost because of their specificity. In this section we attempt to estimate directly one component of the unique productive contribution of the elderly in a setting in which specific experience is potentially valuable—where technology is stagnant but "states of nature" vary with some likelihood of repetition. In particular, we hypothesize that elders in 'traditional' agriculture can provide location-specific information about the allocation of resources which are useful to the younger generation in mitigating the effects on farm profits of adverse states of nature. Because of the shorter life spans of the young relative to the elderly, the latter are more likely to have directly observed, and thus to have acquired more information about, any currently experienced state of nature. To estimate the value of that information, we utilize a data set consisting of a three-year panel of 4000 rural (farm and non-farm) Indian households surveyed by the National Council of Applied Economic Research. These data, covering the years 1968-1971, provide household information for each of the three years on farm profits, agricultural inputs and demographic characteristic and indicate whether or not weather conditions adversely affected crops in the village in which each household resides.

To estimate the value of the elderly in agriculture subject to stochastically determined states of weather, let farm profits gross of family-owned factor costs for farm i in village k in a particular year be given by (1)

$$(1) \quad \pi_{ik} = e^{\gamma(Z_i, \lambda_k, \omega_k)} \prod_j X_{ij}^{\alpha_j} (1 - \theta \omega_k)$$

where the Z_i are individual farm inputs (including elders) and the λ_k the set of village-level factors valuable in reducing the effects of adverse weather on farm profits. The X_i are the set of all farm and location-specific fixed factors, including possibly some Z_i , which influence profits under all (adverse or 'good') states of nature, ω_k is an index of adverse weather in the village which is assumed to be a positive discrete random variable with frequency function $f(\omega)$, $f(0)$ being the frequency of good weather. The γ function thus embodies the hypothesis that certain factors are especially useful in adverse weather; the parameter θ represents the proportional decline in the contributions of the fixed factors to profits due to sub-optimal weather.

In estimating a profit function such as (1), a major problem is the presence of unobserved farm-specific fixed factors X_i , such as entrepreneurial ability, which may be correlated with the observed factors, such as the Z_i and λ_k . However, if we define, for convenience, good weather as $\omega_k = 0$, the profit function (1) in adverse weather can be written as

$$(2) \quad \pi_{ik}^B = e^{\gamma(Z_i, \lambda_k; \omega_k)} \left[\pi_{ik}^G \right]^{(1-\theta\omega_k)}$$

Given the panel nature of the data, since we know, for most farms, profits under 'good' (π^G) as well as adverse (π^B) weather conditions it is thus not necessary to have information on or to specify the set of farm-specific fixed factors not in the γ function. A limitation of the data, however, is that we do not have information on ω_k beyond the dichotomous good-bad distinction. We thus estimate two variants of (2), in which the γ -functions, normalized at $\omega = 1$, are alternately,

$$(3) \quad \gamma_{ik} = \sum_{j=1}^5 \gamma_{zj} Z_{ij} + \sum_{j=1}^2 \gamma_{kj} \lambda_{kj} + \sum_{j=1}^2 \gamma_{Tj} D_{Tj} + \epsilon$$

$$(4) \quad \gamma'_{ik} = \sum_{j=1}^5 \gamma'_{zj} Z_{ij} + \sum_{j=1}^2 \gamma'_{kj} \lambda_{kj} + \sum_{j=1}^{58} \gamma_{Dj} D_{Dj} + \epsilon'$$

where Z_1 is a dummy variable representing the presence or alternatively a variable indicating the number of elderly, defined as individuals aged 60 or over; Z_2, Z_3, Z_4 are the number of individuals aged 50-59, 40-49 and 15-39 in the household;³ Z_5 is the highest level of schooling attainment in the household, and λ_{k1} and λ_{k2} are dummy variables indicating respectively the presence of an agricultural extension program in the village and whether or not the village is electrified, facilitating irrigation. The D_{Tj} and D_{Dj} are year and district dummies; ϵ and ϵ' are random error terms.⁴

Taking the log of (2) and substituting (3) or (4), we obtain the estimating equations (5) and (6)

$$(5) \quad \text{model 1: } \ln \pi_{ik}^B = \sum \gamma_{zj} Z_{ij} + \sum \gamma_{kj} \lambda_{kj} + \sum \gamma_{Tj} D_{Tj} + (1 - \theta) \ln \pi_{ix}^G + \epsilon$$

$$(6) \quad \text{model 2: } \ln \pi_{ik}^B = \sum \gamma'_{zj} Z_{ij} + \sum \gamma'_{kj} \lambda_{kj} + \sum \gamma_{Dj} D_{Dj} + (1 - \theta') \ln \pi_{ik}^G + \epsilon'$$

Model 1 assumes that adverse weather conditions are identical across all villages and districts in a given year and that there is no significant variation across geographical areas in environmental factors that permit differential adaption to adverse weather. Model 2 allows for interdistrict variation in the impact of adverse weather, directly or

as modified by any district-level λ 's. To preserve degrees of freedom and retain some degree of parsimony, both models exclude interactions between the level of weather adversity and the X's, Z's or λ 's.⁵ To take into account variability in 'good' weather conditions and to reduce measurement error in π_i^G , however, we choose a subsample of households experiencing only one adverse weather year out of the three sample years; π_i^G is thus the average of profits in the two 'good' years.⁶ Our sample thus consists of 895 farm households.⁷ Table 1 provides descriptive statistics for this subsample.

The relative contributions to profits of young versus old under adverse weather conditions depend on both the effects of bad weather on the demand for physical labor and on the age-gradient of physical capacities for work as well as on the returns to experience. If it is (reasonably) assumed that persons over 60 contribute less to output as physical workers than their offspring under all weather conditions, the finding that their contribution to output exceeded that of the younger workers in bad weather, i.e., $\gamma_1 > \gamma_2, \gamma_3, \gamma_4$ would be supportive of the hypothesis that there are returns to the experience accumulated by the elderly. We have included schooling, extension and electrification in the γ -functions to ascertain if formal education also contributes to allocative efficiency under disequilibrium states (Schultz, 1975), in this case brought about by weather conditions, and to estimate the contributions of extension services and the availability of electricity under adverse weather. To the extent that schooling and family extension are both choice variables for the farm household, the finding that both are valuable in adverse weather would suggest behavioral linkages

Table 1

Means and Standard Deviations: Farm Households with Adverse Weather
in One Year, 1968-69, 1969-70, 1970-71

Variable	Mean	S.D.
Average Farm Profits in Good Weather (Rupees)	3970.9	3691.6
Farm Profits in Adverse Weather (Rupees)	3462.3	4106.8
Presence of Family Member 60+	.415	.493
Number of Family Members 60+	.486	.640
Number of Family Members 15-59	3.55	1.79
Number of Family Members 50-59	.473	.628
Number of Family Members 40-49	.588	.669
Number of Family Members 15-39	2.49	1.56
Highest Schooling Level	2.32	1.65
Village Extension Program	.540	.499
Village Electrified	.364	.481
Adverse Weather in 1968-69	.589	
Adverse Weather in 1969-70	.268	
Adverse Weather in 1970-71	.142	
Number of Households		895

between family structure, schooling investment and weather patterns. These implications are formally discussed in section III.

b. Empirical Results

Table 2 reports the profit function estimates under various specifications of model 1, which excludes district-specific effects, and model 2, which includes them. Estimates for each γ -function specification excluding $\ln \pi^G$ as a regressor are also reported to illustrate the importance of utilizing the panel feature of the data. As can be seen, the estimates of the γ -function are quite sensitive to the exclusion of farm-specific, good weather profits within each model. The elder's effect is raised by a factor of three as is the education effect when π^G is omitted. These results thus suggest that estimating a profit function under conditions of good weather from a single cross-section would be subject to significant bias due to omitted unobservables. Given the short time-series in our panel, moreover, there seems to be no fruitful strategy for estimating the impact of the Z and λ variables on good weather profits. Accordingly, we discuss only those results which "control" for fixed factors.

Based on the dummy variables for presence of an elderly household member, the results indicate that an elder over 60 years of age augments profits in bad weather by between 9 and 16 percent depending upon the model specification. Each additional adult under 60 has at most one-half as

Table 2

Contributions of Farm and Village Inputs to Agricultural Profits in Adverse Weather:

Farm Households 1968-69, 1969-70, 1970-71

Variable/ Specification	Presence 60+	Number 60+	Number 15-59	Number 50-59	Number 40-49	Number 15-39	Highest Education	Vlg. Exten- sion Program	Vlg. Elec- trification	Avg. In Profits- Good Weather	R ²	F	d.f.
<u>Model 1^a</u>													
(1)	.143 (2.16)	-	-	-.030 (0.51)	.022 (0.44)	.023 (1.11)	.086 (4.38)	.113 (1.71)	.107 (1.58)	.857 (26.19)	.516	94.45	884
(2)	.342 (3.91)	-	-	.085 (1.20)	.080 (1.22)	.076 (2.77)	.193 (7.53)	.053 (0.61)	.138 (1.54)	-	.141	16.22	885
(3)	.356 (2.45)	-	.017 (0.93)	-	-	-	.087 (4.40)	.116 (1.75)	.107 (1.59)	.856 (26.19)	.516	118.11	887
(4)	.339 (4.04)	-	.077 (3.29)	-	-	-	.193 (7.54)	.053 (0.60)	.138 (1.54)	-	.141	20.90	888
(5)	-	.119 (2.44)	.016 (0.88)	-	-	-	.087 (4.41)	.116 (1.75)	.105 (1.56)	.856 (26.17)	.516	118.09	887
(6)	-	.266 (4.10)	.075 (3.19)	-	-	-	.193 (7.54)	.052 (0.59)	.133 (1.49)	-	.142	20.98	888
<u>Model 2^b</u>													
(1)	.089 (1.48)	-	-	.023 (0.46)	.070 (1.51)	.045 (2.37)	.067 (3.22)	-.198 (1.78)	.246 (2.13)	.777 (21.86)	.663	24.67	830
(2)	.235 (2.23)	-	-	.141 (2.23)	.206 (3.56)	.113 (4.12)	.191 (7.86)	-.235 (1.68)	.374 (2.59)	-	.468	11.23	829
(3)	.092 (1.61)	-	.045 (2.58)	-	-	-	.067 (3.32)	-.195 (1.75)	.246 (2.14)	.778 (21.95)	.662	25.47	831
(4)	.217 (3.04)	-	.123 (5.73)	-	-	-	.192 (7.91)	-.229 (1.64)	.369 (2.56)	-	.467	11.55	832
(5)	-	.066 (1.48)	.045 (2.56)	-	-	-	.067 (3.31)	-.191 (1.71)	.241 (2.09)	.777 (21.90)	.662	25.45	831
(6)	-	.177 (3.21)	.123 (5.71)	-	-	-	.191 (7.88)	-.223 (2.47)	.357 (2.47)	-	.467	11.58	832

t-values in parentheses

large an impact. Under both the model 1 and 2 regimes, an F-test indicates that the hypothesis that the three younger age groups have identical effects on profits cannot be rejected.⁸ Because of collinearity between the presence and number of old people 60 and over, however, we could not obtain reliable estimates to ascertain rigorously if the returns to having additional elders, given the presence of one, decline, as might be anticipated. Specification 5, which replaces the elder presence variable with the number of elders shows a slightly lower effect for numbers and does as well in terms of goodness of fit and coefficient precision.

These results thus suggest that the expected annual pecuniary contribution to farm profits of a family member over age 60, given a sample mean probability of adverse weather of one every three years is, assuming no other productivity, approximately 110 to 185 rupees.⁹ Based on the total earnings of non-farm agricultural households with two adults and four children, this contribution of an elder alone would represent a 50 to 80 percent offset to the annual average consumption of a rural, prime-aged adult.¹⁰

Of the other coefficients, the estimates of θ suggest that on average adverse weather reduces the marginal contributions of fixed factors by from 14 to 22 percent. Schooling also appears to play an allocative role -- one additional year of schooling has a 6.5 to 8.5 percent gross return in bad weather, in addition to any other benefits provided. While the coefficients of the farm-specific schooling and elderly variables appear somewhat robust to model specification, the extension program and electrification estimates are sensitive to the use of the set of district dummies, which appears to "significantly" reduce in all specifications the residual sum of squares.¹¹

While the availability of electricity in the village contributes positively to the profits of farmers under both models, the estimates more than double when the district dummies are included. The results from specification (3) model 2, suggest that farmers' ability to use electric power, which is critical for the use of irrigation (Singh, 1977), augments gross farm profits by almost twenty-five percent under adverse weather conditions.

The agricultural extension program estimates, while appearing to suggest that such services increase farm profits under adverse weather conditions when no account is taken of inter-district variations in adversity, appear to imply that optimal adaption to bad weather is impeded by them under model 2. This latter result may suggest that extension programs are located in villages for which adaption to adverse weather is quite difficult. If so, the correlation of the extension variable with the residuals in (5) or (6) would impart bias to all coefficients. Exclusion of the possibly "endogenous" village-level program variables from the γ -functions alters only negligibly, however, the estimates of the contributions of the elderly to farm profits under adverse weather conditions.

III. Family Structure and Expected Weather Adversity

a. A Theoretical Model

The results of the previous section demonstrated the existence of a positive interaction between adverse weather and the presence of an elder within the family in terms of farm profits. In this section we explore the implications of this observation for family structure. To take the simplest optimization framework, we assume that the agricultural household attempts to maximize expected profits subject to weather variability. Analogous to

(1), the net profit (denoted by $*$) function is $\Pi_{ikt}^* = \Pi^*(Z_i; \lambda_k, X_i, \omega_{kt})$.

The farm household's maximization problem is thus given by

$$(6) \quad \max_{Z_i} E \Pi_{ik}^* = \sum_{t=0}^T \Pi_{ikt}^* f(\omega_{kt})$$

with first-order conditions, for the two choice variables, (experience, as embodied in elders, and schooling) given by

$$(7) \quad E(\Pi_{Z_j}^*) = 0 \quad j = 1, 2.$$

Expression (7) indicates merely the equality of expected marginal revenue and expected marginal cost for each element of Z , with the demand function for elders' services clearly related to the parameters of the frequency distribution of adverse weather, the elements of the district level characteristic vector λ_k and those of the farm level vector of fixed factors X_i .

A useful method for isolating the comparative static impact of adverse weather on the demand for the Z_i 's is to define a multiplicative (ϕ) and an additive (δ) parameter shift for the random variable. The additive shift alters the mean of the distribution while the multiplicative shift alters its spread with the mean held constant by appropriate manipulation of the additive shift. Substituting $\phi\omega_t + \delta$ for ω_t in (7) and totally differentiating with respect to δ and ϕ yields comparative static effects in terms of the characteristics of the weather distribution. At the initial point of equilibrium, the effect on the demand for each Z of a change in the mean is

$$(8) \quad \left. \frac{dz_j}{d\delta} \right|_{\substack{\phi = 1 \\ \delta = 0}} = \frac{-E(\Pi_{Z_j \delta}^*) E(\Pi_{Z_k Z_k}^*) + E(\Pi_{Z_k \delta}^*) E(\Pi_{Z_j Z_k}^*)}{\Delta} \quad \begin{array}{l} j = 1, 2 \\ k = 1, 2 \\ j \neq k \end{array}$$

where Δ is the determinant of the expectational matrix of second partials, which must be positive by second-order conditions. Similarly, the mean-preserving spread effect on the demand for the Z_j 's is

$$(9) \quad \left. \frac{dz_j}{d\phi} \right|_{\substack{\phi = 1 \\ \delta = 0}} = \frac{-\left[E(\Pi_{Z_j \phi}^*) - E(\omega) E(\Pi_{Z_j \delta}^*) \right] \left[E(\Pi_{Z_{kk}}^*) \right] + \left[E(\Pi_{Z_k \phi}^*) - E(\omega) E(\Pi_{Z_k \delta}^*) \right] \left[E(\Pi_{Z_j Z_k}^*) \right]}{\Delta}$$

where $\left. \frac{d\delta}{d\phi} \right|_{\phi=1} = -\bar{\omega}$.

The gross profit function estimates of the previous section suggest $E(\Pi_{Z_j \delta}^*) > 0$ both in the case of the elderly and schooling as long as the marginal cost of each is independent of weather adversity. In addition, supplementary profit function regressions which interact the elements of Z tend to show that the elderly and schooling are substitutes, i.e., $E(\Pi_{Z_j Z_k}^*) < 0$, and $E(\Pi_{Z_k Z_k}^*)$ must be negative to satisfy second-order conditions. While the resulting sign of either $\left. \frac{dz_j}{d\delta} \right|_{\phi=1}$ is still indeterminate, manipulation of equation (8) implies that both mean effects cannot simultaneously be negative, as

$$(10) \quad E(\Pi_{Z_j Z_j}^*) \frac{dz_j}{d\delta} + E(\Pi_{Z_j Z_k}^*) \frac{dz_k}{d\delta} = -E(\Pi_{Z_j \delta}^*) \quad \begin{array}{l} j, k = 1, 2 \\ j \neq k \end{array}$$

It is easily seen that if the Z 's were complements ($E(\Pi_{Z_j Z_k}^*) > 0$), weather

distribution mean effects on both Z's would have been predicted to be positive. Only a weak test of the model is, however, available given the evident substitution relationship between schooling and experience.

In order to determine even the sign of the impact of a change in the spread (mean-preserving) of the ω distribution on the Z's, knowledge of $E(\Pi_{Z_j\phi})$ is required though in itself not sufficient as $E(\Pi_{Z_j\delta})$ is also relevant. In particular, if $E(\Pi_{Z_j\phi}) > 0$ as might seem plausible, $\frac{dz_j}{d\phi}$ could not be signed even if Z_j and Z_k were complements. The point, however, is that the spread effect would only by coincidence be zero, and this provides another weak test of the model.

b. An Empirical Application

The general implication of the model is that the prevalence of the extended family (and the level of schooling) should be related, under some conditions in a particular way, to the parameters of the frequency distribution of adverse weather. The major problem in the empirical application of the model is the difficulty of obtaining information on the parameters of $f(\omega)$, namely δ and ϕ . We now demonstrate, however, how the sample moments of the distribution of farm profits for each farm, which can be computed from the three-year panel data, can be used in conjunction with data on the distribution of one important weather variable, rainfall, to estimate linear combinations of the impact of altering the mean and spread of $f(\omega)$ on the demand for elders and thus family structure.

The demand functions for Z, corresponding in linear form to those derived from the model, which we would like to estimate, are

$$(11) \quad Z_{jik} = \alpha_{1j}\delta_k + \alpha_{2j}\phi_k + \alpha_{3j}X_i + \alpha_{4j}\lambda_k \quad j = 1,2$$

where i again refers to the farm and k to the area, Z_1 refers to elders and Z_2 schooling. We are particularly interested in estimating α_1 and α_2 but δ_k and ϕ_k , and X_i and λ_k are not observed. However, note that the latter two variables are uncorrelated with either δ_k or ϕ_k .

Suppose that in each area we have information about the distribution of rainfall that completely describes δ_k and ϕ_k , i.e., $\delta_k = g(R_k)$ and $\phi_k = h(R_k)$ where R_k is a vector of area-specific rainfall distribution parameters. While g and h are themselves unknown, so that α_1 and α_2 can still not be identified from the rainfall data alone, there is still unexploited information, namely that the profit distribution parameter are themselves functions of the same variables as are the demand functions, namely from (1),

$$(12) \quad M_{ik\ell}^{\Pi} = \beta_{1\ell}\delta_k + \beta_{2\ell}\phi_k + \beta_{3\ell}Z_{1ik} + \beta_{4\ell}Z_{2ik} + \beta_{5\ell}X_i + \beta_{6\ell}\lambda_k$$

where $M_{ik\ell}^{\Pi}$ is the ℓ^{th} central moment of the profit function for farm i in area k.

Now consider the following estimating equations for Z in terms of the observable profit moments and the unobservables X and λ .

$$(13) \quad Z_{jik} = A_{1j}M_{ik1}^{\Pi} + A_{2j}M_{ik2}^{\Pi} + A_{3j}X_i + A_{4j}\lambda_k \quad j = 1,2$$

For convenience, the first two moments of the profit function are assumed

to adequately describe the impact of weather variability on the demand for Z.

Solving for α_{11} , α_{21} , α_{12} and α_{22} from (11), (12), and (13) and noting that, from the first order conditions (7), β_{31} and $\beta_{41} = 0$, yields

$$(14) \quad \alpha_{11} = \frac{A_{11}\beta_{11} + A_{21}\beta_{12}}{K_1} + \frac{(A_{12}\beta_{11} + A_{22}\beta_{12})(A_{21}\beta_{42})}{K_1K_2} D^{-1}$$

$$(15) \quad \alpha_{12} = \frac{A_{12}\beta_{11} + A_{22}\beta_{12}}{K_2} + \frac{(A_{11}\beta_{11} + A_{21}\beta_{12})(A_{22}\beta_{32})}{K_1K_2} D^{-1}$$

$$(16) \quad \alpha_{21} = \frac{A_{11}\beta_{21} + A_{21}\beta_{22}}{K_2} + \frac{(A_{12}\beta_{21} + A_{22}\beta_{22})(A_{21}\beta_{42})}{K_1K_2} D^{-1}$$

$$(17) \quad \alpha_{22} = \frac{A_{12}\beta_{22} + A_{22}\beta_{22}}{K_2} + \frac{(A_{11}\beta_{21} + A_{21}\beta_{22})(A_{22}\beta_{32})}{K_1K_2} D^{-1}$$

where $K_1 = 1 - A_{21}\beta_{32} > 0$, $K_2 = 1 - A_{22}\beta_{42} > 0$,

and $D = 1 - \frac{(A_{21}\beta_{42})(A_{22}\beta_{32})}{K_1K_2} > 0$.

Assume for the moment that all of the β terms, the effects of the weather distribution parameters on the moments of the farm profit distribution, can be signed a priori with an appropriate specification of the profit function so that it is only the signs of the A's that are unknown. Estimation of (13) by ordinary least squares must yield inconsistent estimates of the true impact of weather variability on the demand for Z_j since whatever unobserved λ and X variables are contained in (13) must be correlated with M_{ikl}^{Π} , as there is no determinant of one that is not a determinant of the other as well. Since δ and ϕ are functions of the rainfall frequency

distribution, however, and δ_k , ϕ_k and the R are orthogonal to X_i and λ_k that component of M^Π variation due solely to weather can be estimated consistently, i.e. $\hat{M}_{ikl}^\Pi = \beta_{1l} \delta_k(R) + \beta_{2l} \phi_k(R) = M(R)$. Substituting the \hat{M}^Π 's into (13) and relegating X and λ to the residual, since they are uncorrelated with \hat{M}^Π , enables consistent estimation of A_{ij} and A_{2j} . In the next section, in which consistent estimates of the A_{ij} 's are presented, we discuss the conditions under which those estimates can yield the signs of the underlying parameters of interest, the α_{ij} 's.

c. The Data and Empirical Results: Farm Households

To implement the two-stage procedure for estimating the relationship between the moments of the expected profit distribution, family extension and schooling investment (the A_{ij} 's), we utilize 30 years (1921-1950) of monthly rainfall data -- days and levels (in centimeters) of rain¹² -- for each of 73 of the 100 districts covered in the NCAER survey.¹³ The first three central moments for each rain variable distribution were computed for the four critical planting and harvesting months, June, July, September and October; a total of 24 rainfall variables for each district. Table 3 provides the 73-district-level means and variances of farm profits, aggregated from the household data. As can be seen from the tables, there is considerable variation in both the characteristics of the rainfall distributions and farm profit levels and variability across the Indian districts.

Table 4 reports on the proportions of extended family households for various age-structure definitions within farm and non-farm samples. The table indicates that the importance of family extension across generations

Table 3

Means and Standard Deviations: District Rainfall Levels and Variability From 1921 to 1950 For Selected Months and Annual Farm Profit Variability 1969-1971
(standard deviations in parentheses)

Variable	June	July	September	October
Mean Days of Rain 1921-1950	7.18 (4.22)	13.69 (4.55)	8.39 (3.42)	3.57 (3.63)
Mean Rainfall (cm) 1921-1950	150.0 (130.8)	301.2 (129.2)	175.3 (83.0)	64.3 (61.3)
Variance in Days of Rain 1921-1950	10.7 (5.0)	13.9 (5.7)	11.9 (3.8)	14.3 (7.8)
Variance in Rainfall 1921-1950	10710 (9299)	20006 (16561)	11887 (7012)	5288 (9400)
Skewness in Days of Rain 1921-1950	.434 (.497)	.004 (.432)	.299 (.651)	.966 (.657)
Skewness in Rainfall 1921-1950	1.26 (.811)	.788 (.694)	1.07 (.856)	1.66 (.859)
Mean Farm Profits 1969-1971		3600 (1919)		
Variance in Farm Profits ($\times 10^{-3}$) 1969-1971		11445 (13395)		
Number of Districts		73		

Table 4

Proportion of Households by Family Age Structure and Land Ownership

Sample	(1) Ages 15-39 and 50+ or 15-49 and 60+	(2) Ages 15-39 and 60+	(3) Ages 25-39 and 50+ or 25-49 and 60+	(4) Ages 25-39 and 60+	(5) Age 60+	Number of Households
Farm households	.647	.364	.493	.259	.381	3330
Non-Farm households	.543	.291	.455	.247	.340	1157

is clearly sensitive to the age criteria, although the correlation between these proportions across districts is quite high. Moreover, as is discussed in more detail in the next section, there appear to be no distinct differences in inter-generational family jointness between households with and without land, whatever the criteria chosen. Because of the possibility that weather variation will be positively correlated with the mortality of very old elders and because the essence of the extended family hypothesis is the existence of mutual benefits accruing to two generations of adult kin, we employ the first criterion, which selects on the presence of "young" 15 to 39 and at least one elder over 50 or the presence of young 15 to 49 and an elder over 60, to define the dependent variable representing the prevalence of intergenerational extension.¹⁴

The two-stage least squares estimates for farm households, corresponding to equations (13), for the family structure and mean highest schooling variables are reported in Table 5.¹⁵ The estimates utilizing both the mean and variance of profits indicate that there is a statistically significant relationship between expected profit variance and intergenerational family extension, with no significant effect of predicted mean profits. For schooling, however, there is a "significant" relationship with mean profits but evidently none with profit variance. Interestingly, for both dependent variables predicted mean profits appear to have a positive, significant impact when only that variable is included on the right-hand side. Specification one, which excludes expected profit variability, thus would provide potentially misleading results in suggesting the apparent

Table 5

Two-Stage Least Squares Regression Coefficients: Farm Families with Elders,^a
 Schooling Attainment and Farm Profit Uncertainty, Indian Districts

Variable	'Elderly' Families		Schooling	
	(1)	(2)	(3)	(4)
Expected Mean Farm Profits ($\times 10^{-3}$)	.027 (1.82)	.001 (0.10)	.178 (2.44)	.180 (1.84)
Expected Farm Profit Variance ($\times 10^{-5}$)	-	.002 (1.89)	-	-.001 (0.14)
Intercept	.507 (9.12)	.516 (8.26)	1.490 (5.40)	1.513 (5.35)
n		73		73

^aFamilies with either i) at least one person aged 15-39 and one person aged 50+ or ii) at least one person aged 15-49 and one person aged 60+.

importance of mean net income for explaining family structure in farm households. Moreover, experimentation with the alternative definitions of family structure reveals that the family extension results obtained are not sensitive to the definitions chosen except that use of definition 3, which excludes two-generation families with elders less than 50, resulted in a greatly reduced profit variance effect and significantly stronger mean effect, probably due to the inverse relationship between mortality and income.

To translate the profit parameter estimates from Table 5 into the parameters related to the weather distribution effects, we assume that the profit function is a particular variety of the general form given by (1), so that β_{11} and $\beta_{12} < 0$ (see the Appendix). It can then be shown, from expressions (14) through (17), that α_{12} , the effect of the mean weather shift parameter δ on schooling attainment is negative while all of the other α 's are unsigned without further assumptions. The negative mean effect on schooling is consistent with the model, given that, as our profit function estimates suggested, schooling and experience are substitutes in the γ -function; a negative effect would have indicated rejection of the model if schooling and the elderly were complements. The model also predicts (expression (10)), given that $\alpha_{12} < 0$, that the effects of weather adversity on family structure cannot be negative; the sign of α_{11} cannot be ascertained, however, because without additional assumptions about the ω -distribution the effect of an increase in schooling level on profit variance (β_{42}) cannot be signed. The inability to sign the rest of the β 's without further information on the exact form

of $f(\omega)$, and the profit function, the ω -spread effects, as noted, cannot be signed.

The demand function results when translated into the parameters of the model thus do not reject any of the implications of the theoretical framework; nor are they inconsistent with the profit function findings of substitutability. Notice that if $A_{11}, A_{12} > 0$ and $A_{21}, A_{22} = 0$ had been found upon estimation, the model would have been rejected since that configuration would have implied that α_{11} and α_{12} were both negative. While only weak tests could be derived from the model, due to the lack of information on the exact form of the weather adversity distribution, on a more general level the likelihood of a relationship between farm family structure, schooling and higher moments of the predicted farm profit distribution, in this case the variance, indicated by the theory, was confirmed by the data and is an implication not readily derived from alternative models proposed to explain the existence of the extended household in agriculture.

d. The Market for the Services of Elders: Non-Farm Households

As indicated by Table 4, the structures of farm (landed) and non-farm (landless) households appear quite similar. In an agricultural society such as India, in which the primary form of wealth (other than children) is land and in which technology has been stable, differences in household incomes would be almost entirely determined by land size or quality for a given state of weather. Accordingly, the simple old-age security explanation for the extended family would appear to suggest that landed elders would be less likely to be situated in extended family arrangements -- would have less need for the support of the younger generation -- than would their landless counterparts because of wealth differences. The wealth-transfer hypothesis would appear to predict more inter-generational extension of farm relative to non-farm families, given

ownership of the land by the elderly. Within the specific experience framework, however, if the landless engage in agricultural labor, the elderly among them would differ from their landed counterparts only in possibly having less of a commitment to a single farm. Because, moreover, it is unlikely that the technical knowledge of methods to cope with adverse weather is wholly non-transferable across farms, there appears to be some scope for a market, especially since "own" elderly are in inelastic supply. Indeed, the greater the degree of substitutability of landless elders for own elders, the smaller the difference we would observe in extended family arrangements. Just as the landed elders might augment family income in adverse weather, and impart their valuable knowledge gained from experience to their offspring, so too may the landless elders. Thus the specific experience hypothesis suggests that in a static environment, differences in the family structures of relatively asset-rich and asset-poor households might be quite low, as suggested by our data.

A direct test of the extent to which there is a market for the unique services of the elderly, i.e., a wage premium paid to the experienced during adverse weather conditions, would be to estimate adverse weather wage functions for individuals from landless households analogous to the adverse weather profit functions given by (2). However, wages are reported for only the last year of the NCAER survey. Estimates of the relationship between age (experience) and "bad weather" wages thus cannot be obtained controlling for the individual's "good weather" wages, thus making omitted variable bias quite likely, as was true for the profit

estimates obtained omitting good weather profits. In the absence of the wage information, we instead utilize an indirect test, ascertaining if the structure of landless families and their schooling investment also varies with expected weather adversity, using the same two-stage farm profit methodology employed for the landed households. If there is a market for the services of elders, we would expect to observe similar relationships among landed and landless families to the moments of the expected farm profit distribution.

Table 6 displays the relevant parameter estimates for the landless households, which indeed appear to replicate the landed household results reported in Table 5. Thus, the variance but not the mean of expected farm profits appears to be importantly related to the prevalence of intergenerational extension in both farm and non-farm households, while only expected mean profits affect schooling investment in both rural household types. In districts where landed households are more likely to be extended ~~so~~ too are landless households and those districts happen to be characterized by greater weather induced farm profit variability.

IV. Summary and Further Implications

The major purpose of this paper has been to propose and test an economic theory of the extended family. We explored the hypothesis that family-specific information accumulated by and embodied in the elderly provides a fundamental explanation for the prevalence and continuation of the intergenerationally extended family within the context of a technologically stable environment subject to historically observed stochastic events. In such a setting elders are productive family members and there exist incentives for each succeeding generation of kin to live with each other.

Table 6

Two-Stage Least Squares Regression Coefficients: Non-Farm Families with Elders,^a
 Schooling Attainment and Farm Profit Uncertainty, Indian Districts

Variable	'Elderly' Families		Schooling	
	(1)	(2)	(3)	(4)
Expected Mean Farm Profits ($\times 10^{-3}$)	.046 (2.01)	.013 (0.39)	.316 (2.59)	.298 (1.87)
Expected Farm Profit Variance ($\times 10^{-5}$)	-	.001 (1.54)	-	-.0003 (0.17)
Intercept	.227 (2.59)	.241 (2.40)	.451 (0.97)	.459 (0.86)
n ^b		70		70

^a See note to Table 5.

^b Three districts omitted because number of non-farm sample households in each was less than 20.

Applying this view to a traditional agricultural setting subject to recurrent, stochastic states of nature affecting the optimal allocation of farm inputs, we developed a framework within which testable implications were extracted concerning the role of elders in the production process and the demand for the elderly. Based on longitudinal household and district-level time-series rainfall data from India, we obtained evidence that the gross returns from experience (embodied in elders) under conditions of recurrent disequilibria caused by weather variability were economically significant and comparable to those from schooling. We also found, consistent with the framework developed, that the cross-sectional variation in the prevalence of extended families as well as schooling investment were significantly related to the likelihood of disequilibrating events for which experience and schooling were most useful. The latter findings were also obtained for landless households, indicating the existence of a market for the unique skills of the elderly. These phenomena did not appear readily explicable by alternative theories of the extended family found in the social science literature, although such hypotheses have not been rigorously formulated in terms of their testable implications.

While we have focussed narrowly upon a particular variant of the specific experience hypothesis in order to facilitate rigorous testing, the hypothesis appears as capable as alternative theories in addressing the broader issues of cross-cultural family structure variation and the link between industrialization, urbanization and the extended family.

By pitting the theory against the data within the restrictive framework utilized, however, we have established a firmer empirical foundation for the credibility of the broader implications of the hypothesis which are inherently more difficult to verify. Even with respect to these, however, we believe that the specific-experience hypothesis can be subjected to test.

As a first example, consider the impact on extended family formation of introducing new technologies. Almost definitionally, the accumulated knowledge of elders becomes obsolete in coping with adverse weather.¹⁶ Given the decline in productivity and thus the reduced demand for elder's services, the specific experience hypothesis would predict a decline in extended family formation.

As another concrete example, suppose the government were to randomly introduce family planning clinics into certain areas. The direct effect presumably would be to reduce fertility. In so doing, however, the value of the elderly, who are child-rearers with family-specific experience, and thus the benefits to perpetuating the extended family, could be reduced.

The urban-rural or industrial-nonindustrial distinction has drawn the most attention in the sociological literature. As a generalization, the extended family is less likely to be observed in the urban industrial setting. Although the specific-experience hypothesis, with its central notion being the value of information in a stable though possibly stochastic environment, is clearly compatible with this observation, several further points in this connection should be noted. First,

abstracting from the issue of selective migration, migrants from the rural to the urban sector should be less likely to maintain the extended family given the absence of any relevant experience of elders in the urban environment. Second, if the urban environment is itself stable but subject to random fluctuations, e.g., business cycles of varying amplitude, with which the elderly have had more experience in coping, the extended family would not be a sub-optimal arrangement among native urbanites.

Finally, a cross-country comparison of family structure would have to focus on exogenous differences in environment in order to avoid questions of causality. Weather variation is an obvious candidate since it is truly exogenous and important in agricultural production. In addition, however, environmental factors conducive to technical change would also be of significance in the determination of family structure and it is those factors which require discovery and attention.

Appendix

The purpose of this appendix is to demonstrate the validity of the signs imposed on the β coefficients of equation (12) utilizing the form of the profit function estimated in Section I. Consider a net profit analogue of (1) which assumes that the marginal cost of the fixed factors and of the own farm inputs are independent of weather adversity, as in

$$A.1 \quad \pi^* = e^{\gamma(Z_j; \omega)} \prod_1 (X_1^\alpha)^{1-\theta\omega} - C(Z, X), \text{ where } \gamma(Z_j; \omega) = \gamma_0 \omega + \gamma_1 Z_1 \omega + \gamma_2 Z_2 \omega, \omega \geq 0.$$

Substituting $\phi\omega + \delta$ for ω , and assuming that $E\pi^* > 0$, $\gamma_\delta < 0$ and $\gamma_\phi < 0$, the effects of changing δ and ϕ on the mean and variance of profits are, (letting $\pi' = \pi^* + C$):

$$A.2 \quad \beta_{11} = \frac{\partial E\pi'}{\partial \delta} = (\gamma_\delta - \sum_1 \alpha\theta \ln X_1) E\pi' < 0$$

$$A.3 \quad \beta_{12} = \frac{\partial [E(\pi'^2) - E(\pi')^2]}{\partial \delta} = 2(\gamma_\delta - \sum_1 \alpha\theta \ln X_1) \sigma_{\pi'}^2 < 0.$$

$$A.4 \quad \beta_{21} = \frac{\partial E\pi'}{d\phi} = \left[\gamma_\phi - \sum_1 \alpha\theta \ln X_1 \right] E(\omega\pi') < 0$$

$$A.5 \quad \beta_{22} = \frac{\partial [E(\pi'^2) - E(\pi')^2]}{\partial \phi} = 2 \left[\gamma_\phi - \sum_1 \alpha\theta \ln X_1 \right] \{ E(\omega\pi')^2 - E\pi' E(\omega\pi') \} \geq 0$$

The reason for $\beta_{21} < 0$ is because of the assumption that revenues net only of hired inputs (π') are always positive in this functional form.

In the text, we treat β_{21} as if it were ambiguous.

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Footnotes

¹Goode's seminal work advances the hypothesis that the fundamental cause of the nuclearization of the family is industrialization. Although a large body of casual evidence is introduced in support of this contention, the work contains no rigorous formulation of statistical tests. Indeed, the subsequent sociological literature concerned with empirical analysis of Goode's hypotheses deals no better with the difficult task of formulating and implementing statistical procedures. (See Winch (1977) or Lee (1977) for a review of the literature and for examples of the methodology applied to this issue). In part it is the generality of the hypotheses which impedes such endeavors.

²This proposition is analogous to the original specific-training argument of Becker (1964) which, however, pertained to the firm-employee relationship.

³ Z_1 , the variable signifying the presence of an elder, is neither distinguished by sex nor exclusive of either sex. Both males and females are generally active in agricultural work so that there is no presumption that the specific-experience hypothesis should be sex-linked when applied to agriculture. Indeed, in the empirical work presented below we were unable to precisely estimate separate male and female experience payoffs.

⁴There are three years and 59 districts.

⁵Within-district regressions which would keep weather adversity constant would not yield precise estimates since average district sample size is only about 20 farm households.

⁶Year effects account both for differences in output price and in weather adversity that are related to calendar time. Model 2 does not explicitly include D_T since the dichotomous weather variable is itself district-level.

⁷Given the logarithmic representation, farms with negative or zero profits in any of the three years were excluded. Because, however, reported profits are gross of own labor input costs, only 30 households (about 3 percent of the sample) had to be excluded on this basis.

⁸The F-statistic is 0.42 for model 1 and 0.38 for model 2. Both are well below the F-levels of conventional significance.

⁹An alternative interpretation for this result is that elders are more likely to reside in households less affected by adverse weather; i.e., the demand for elders exhibits a positive income elasticity. This argument presupposes, however, that the fluctuations in bad weather profits, controlling for good weather profits and permanent levels of weather adversity (captured by the district-level dummies), are due to systematic differences across farms in the ability to cope with adverse conditions that are not embodied in elders. Otherwise, permanent income would not differ across farm households. Moreover, in the next section we find that while the presence of elders in farm families is related significantly to the expected variance in profits, there is no statistically significant association between expected profit levels and intergenerational extension controlling for the variance. The small difference in the likelihood of observing an elder in landed and landless households, reported below, would also suggest the unimportance of income effects as an explanation for extension.

¹⁰This computation is based on sample mean estimates of 248 and 143 days of market employment and daily agricultural wage rates of 2.5

and 2.0 rupees for adult males and females and assumes that children consume on average one-half the adult level of consumption. For details, see Rosenzweig (1979). Note that the gross contribution and offset estimates are lower bounds, as they assume that the elderly do not consume any own farm output and thus that the presence of family members is not reflected in reported profits on the cost side.

¹¹ For equation (3) the F-statistic is 6.56 while $F_{59, 831} = 1.5$ at the 1 percent level. F-statistics are of similar magnitude for the other specifications.

¹² Rainfall is critical to agriculture in India as over 75 percent of cultivated area is rainfed (See J. Singh).

¹³ Rainfall data were not reported for the other 27 districts contained in the survey

¹⁴ The profit function results were not sensitive to the use of an over 50 dummy.

¹⁵ Results obtained for the first-stage profit means and variance reduced-form equations involving the twenty-four rainfall distribution variables are available from the authors on request.

¹⁶ From the Ethnographic Atlas it can be ascertained that societies characterized by "intensive agriculture with irrigation" have a lower incidence of extended family arrangements (Lee 1977). This is consistent with our profit function finding that electrification reduces the impact of adverse weather on profits and thus may substitute for the services of elders.