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**AGRARIAN STRUCTURE AND AGRICULTURAL PRACTICE:
TYPOLOGY AND APPLICATION TO WESTERN SUDAN**

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Abstract: A typology of models that explain patterns of variation in farm endowments and farm practices and yields shows that insecurity in renting land, financing constraints and the absence of insurance generate patterns of factor use quite different from the famous 'inverse relationship' caused by labor supervision problems. One might expect to observe positive relationships between wealth and yields. Village-level data from western Sudan confirm that such positive relationships are not a theoretical curiosity. Wealthy farmers have higher levels of output per hectare because they use more labor per hectare. Insurance and financing constraints appear to be the crucial market failures.

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In the developing world, a common understanding of the relation between farm practice and agrarian structure is the famous "inverse relationship". Larger farmers appear to use fewer inputs per unit of land, and consequently their yields per hectare are lower than those of smaller farmers. Bardhan once called this statistical regularity one of the stylized facts of traditional agriculture. Berry and Cline, in their survey of agricultural systems around the world, found considerable evidence in favor of the inverse relationship. Numerous theoretical papers have shown how dualistic labor markets, with family labor cheaper and more productive than hired labor because of incentive problems, combined with other market imperfections (e.g., when land ownership determines access to credit, or when market frictions impede renting or selling land) create incentives for larger landowners to cultivate extensively, and smallholders to cultivate intensively (Carter and Wiebe, Eswaran and Kotwal, Feder, Moene, Sen, Swamy, Wiens).

The idea of an inverse relationship has powerfully influenced agrarian policy debates. Land redistribution may be justified as a "win-win" policy, good for equity and good for efficiency. The inverse relationship suggests a benign view of agrarian transitions, with an expanding small-holder sector displacing large landowners, provided agricultural policy does not discriminate in favor of large-scale operations. Binswanger, Deininger and Feder suggest that, since larger landowners are generally able to take advantage of most initiatives, governments favorable to small-holders should refrain from interventions; given the inverse relationship, a "distortion-free" environment promotes the expansion of the small-farm sector.

Because of its policy importance, the inverse relationship must be examined carefully. On the empirical side, work by Bhalla and Roy and Benjamin demonstrates that, in some cases, the inverse relationship is a statistical artifact caused by mis-measuring, or omitting, land quality. When large farms cultivate low-quality land, the efficiency argument for land redistribution and an expanding smallholder sector may not hold; small farmers will not cultivate poor quality land more intensively than large farmers.

Theoretical work tends to omit an important variable- household wealth- from the analysis. Wealth determines the capacity of a household to bear risk, and its capacity to finance production and subsistence during the "hungry" months before harvest. Some researchers, such as Eswaran and Kotwal, argue that access to finance correlates strongly with land ownership. But there are regions where the correlation between land and wealth is weak. In the Sudan-Sahel region of Africa, land has always been abundant. The social relations of control over labor matter more in determining wealth. Moreover, migration and expanded commerce have created new avenues for accumulating capital. Farmers pursue diversified income strategies, enabling even those with little land to break any link between land and access to production financing.

This paper generates a typology of testable empirical hypotheses for situations where land ownership and access to finance are only partially correlated. The typology demonstrates that there are several plausible and compelling circumstances (in terms of factor market imperfections) where we would expect to see a positive relation between farm wealth and yields. Such a positive relationship is more than a theoretical curiosity. Farm-level data from

western Sudan indicates that wealthier farmers did indeed obtain higher yields than poorer farmers (controlling for land and labor endowments).

A positive relationship implies that, far from expanding, the smallholder sector might be contracting over time, as wealthier farmers obtain higher yields, accumulate larger profits, and cultivate larger areas. Poorer farmers will increasingly rely on wage labor for their sustenance. To avoid this situation, and the increasing inequality it generates, policy-makers must continue to develop and strengthen risk-sharing, credit and tenure institutions.

Market Imperfections

A typology of how changes in endowments of land, labor and wealth affect production choices may be constructed by examining how an agricultural decision-maker's optimal labor-land ratio varies under different "regimes" of market imperfections. The production process is represented by $\mathbf{1}F(K,L)$, where K is land (assumed to be of homogeneous quality and undifferentiated in terms of location), L is labor, and $\mathbf{1}$ is a random variable representing risk in production. Households own a stock of land M , land used in cultivation is given by K^f , land rented out K^{ro} earns the rental rate r , and land rented in K^{ri} costs the same. Farmers pay wages w to hired labor L^{hi} . Family labor \bar{L} may either work on the family farm L^f or work for wages L^{ho} .

If markets were perfect, and farmers shared the same technology and goals, there would be no systematic variation in the labor-land ratio or the average value produced per hectare. Models that explain variation thus focus on imperfections in labor, credit, insurance, and land

rental markets. The remainder of this section sets out some simple ways of representing those imperfections.

Labor market imperfections

Smaller farmers often have access to family labor at an implicit wage lower than the effective wage confronting larger farmers. Small farmers may combine work activity with supervision of family labor, or they may not even need to supervise family labor; large farmers must devote increasing amounts of time or resources to supervising hired laborers. Following Feder, Eswaran and Kotwal, and Carter and Wiebe, we assume that the supervision cost of hired labor may be represented by a cost function $s(L^{hi})$, where $s'(L^{hi}) > 0$ and $s''(L^{hi}) > 0$.

Credit Market Imperfections

If liquid assets and access to credit A were not sufficient to meet a fixed subsistence requirement J , then the household would have to allocate some of its labor to earn wages. A wealthier farmer's use of hired labor would be limited since labor must be paid at the time of the work, before production is realized. The constraint is

$$A + w(L^{ho} - L^{hi}) - J \geq 0,$$

where cash flows depend on how much family labor is hired out and how much outside labor is hired in. We assume that land rental income does not enter the constraint (farmers pay rent after the harvest) for all of the models considered below, except Eswaran and Kotwal's model.

Rental Market Imperfections

In many places landowners are wary of renting out their land because of the possibility of losing rights to the land. Sen (p. 441) observed that in India "... a variety of regulations,

traditional and modern, makes renting out land a more hazardous occupation than lending capital..." We assume that, in addition to the normal rental rate r , land rental transactions engender an implicit possible transfer of property rights, the value of which is represented by $- (K^r - K^o)$. If the probability of property rights transfers were independent of the identities or transactions of landowners and renters, then the function would simply represent an adjustment to the rental rate. However, we might postulate a non-linear relation (concave, to be specific, with $\alpha < 0$) in the net area rented, because the likelihood of transfers depends on the "social distance" between the transactors. Landowners will rent first to close relatives and friends who have low probabilities of challenging land rights, and later to more distant relations, and finally to strangers. Increases in land rented increase the probability of disputes. By similar reasoning, renters will first rent from owners who are socially distant, increasing the chances that they might successfully claim the land. The more land they rent, though, the more likely the landowners will be related to them.

Imperfections in Obtaining Insurance

Farmers in developing countries confront several kinds of risk (Carter). At the regional and macro level, variable weather and volatile markets determine yields and prices. At the local level, crop pests and diseases, human illness, and micro-variations in rainfall can devastate a household's production plans. The social mechanisms to mitigate the effects of these risks-covariate and idiosyncratic- are usually very underdeveloped. Despite Townsend's persuasive evidence from the Indian Semi-arid Tropics, the consensus of research with African data is that reciprocal insurance against idiosyncratic risk is imperfect at best (Carter, Udry, Grimard).

Farmers have even more difficulty insuring against covariate risk. Udry finds very little evidence of inter-village lending. Direct data from India on long-distance transfers suggest they are of a limited nature (Rosenzweig). Studies of production practices in India also reveal that poorer farmers respond to risk by changing their crop and variety portfolio (Morduch), and by choosing safe investments (Rosenzweig and Binswanger); if insurance markets were complete no such patterns would be observed. More risk averse farmers weigh the tradeoff of higher expected yields with greater risk, and we represent this by assuming that farmers maximize expected utility.

Agrarian Structure and Variation in Labor-Land Ratios

We now turn to the question of how imperfections in these four factor markets lead producers with different endowments of land, labor, or wealth to carry out different production practices.

The farm household chooses $L^f, L^{hi}, L^{ho}, K^f, K^{ri}, K^{ro}$ to solve the following problem:

$$\begin{aligned} \max EU\{ & A + \mathbf{1} F(K^f+K^{ri}, L^f+L^{hi}) + wL^{ho}-wL^{hi} + rK^{ro}-rK^{ri} + - (K^{ri}-K^{ro}) - \\ & s(L^{hi})\} + \beta[A + wL^{ho}-wL^{hi} - J] \\ \text{subject to} \quad & \text{(a)} \quad M - K^f = K^{ro}, \\ & \text{(b)} \quad \hat{L} - L^f = L^{ho}, \\ & \text{(c)} \quad L^{hi}, L^f, L^{ho}, K^f, K^{ri}, K^{ro} \geq 0. \end{aligned}$$

where β is the Lagrange multiplier on the finance constraint.

The comparative statics of how the ratio of labor-land used in cultivation varies with the endowments A, M and \hat{L} are quite complex, and we derive our results conditional on two

rather restrictive assumptions. First, we follow the literature in assuming that production exhibits globally constant technical returns-to-scale. It remains true that with increasing or decreasing returns-to-scale farmers might have different labor-land ratios. (With only one market imperfection, a typology of comparative statics for these cases may be easily worked out.) Second, we consider the comparative statics when at most two markets are imperfect. That is, we consider a set of sub-problems where at least two markets function well (i.e., where two of the conditions, $s'(L^{hi})=0$, $-(K^{ri} - K^{ro})=0$, $\beta=0$, or $\text{var}(\mathbf{1})=0$, hold). This simplification excludes cases of three or four market imperfections. While Wiens and Feder have tackled models with three market imperfections (in land, labor and risk markets), in general the results become ambiguous and complex. The real world exhibits such complexity, but a complete typology would be beyond the scope of this paper.

Assuming constant returns-to-scale implies that imperfections in only one market cannot generate patterns of variation in yields. All farmers would have the same labor-land ratios, and their scale would be determined by the relevant constraint- family labor, assets, or owned land. Therefore there are only six sub-problems, or models, to consider.

Table 1 presents the comparative statics for these six models; this is the central result of the paper. The intuition and algebra of the comparative statics are straightforward, so we formally derive the comparative statics for only case (f). Note that these results apply in some cases to only one set of households; typically there will be a range of endowments such that households in that range have interior solutions where labor-land ratios do not vary with small

changes in endowments (i.e., the problems are Kuhn-Tucker problems, and different endowments lead to different first-order conditions being binding).

Three important features of the table should be noted. First, all of the models have the same pattern of comparative statics with respect to owned land and owned labor. Assets or liquidity are the variables to study when exploring how variation in practices might be due to market imperfections. To the extent that land proxies for wealth, the effects will be conflated, and this makes the job of distinguishing among alternative explanations more difficult.

Second, the models with imperfect labor markets have the same pattern of comparative statics: wealthier farmers would be expected to have lower labor-land ratios. In addition to the situations described in the introduction, of imperfect labor markets with credit constraints or land rental frictions, an inverse relation also may arise in a situation where imperfect labor markets coincide with inadequate risk-sharing.

Third, the three other cases yield a surprising prediction: yields vary positively with farmer wealth. In model (d), where land rental is imperfect and credit constraints are binding, an increased land endowment leads to a decrease in the labor-land ratio, while greater labor endowment or assets increase the ratio. A wealthier household can apply more labor to agriculture either by hiring in more labor or by using its own labor previously working for wages off the farm. It rents more land to use with this labor, but the benefits of renting land decrease as the amount rented increases, because the probability of claiming land decreases as a household finds itself renting from landowners with whom it has closer social relations. So the ratio of extra labor to extra land is higher than the original labor to land ratio. Consider

what happens as assets decrease. The household uses less labor in agriculture, but it hesitates to give up land rented or land owned because of the higher probability that this land will be claimed by others. The ratio of labor to land falls.

Model (e), which simplifies the analysis of Srinivasan and Bliss and Stern (pp. 70-75), assumes that production credit is available, but agriculture is risky and insurance markets imperfect (and consumption credit unavailable). If, again, renting is insecure, poor farmers will choose to farm larger areas, when they would ordinarily rent out extra land and earn less riskier incomes as wage laborers.

Model (f) assumes that financial markets for both credit and insurance are imperfect. By defining $L^c = (L^f + L^{hi})$ and $K^c = (K^f + K^{ri})$, and using the constraints (a) and (b), the problem may be rewritten as

$$\max EU(A + \mathbf{1}F(K^c, L^c) + w\hat{L} - wL^c + rM - rK^c) + \beta[A + w\hat{L} - wL^c - J],$$

Some households will of course have interior solutions, and marginal changes in their endowments will not affect their optimal production patterns. Very poor, or very risk-averse households, may even have interior "corner" solutions, where they rent out all of their land (or do not rent land if they have none) and work solely as wage laborers. But the more usual case is to see mixed patterns of activities, with some cultivation and some wage-laboring.

The first-order conditions for constrained households will be

$$E\{U'(\mathbf{1}F^K - r)\} = 0$$

$$E\{U'(\mathbf{1}F^L - w)\} - w\beta = 0$$

$$A - J + w\hat{L} - wL^c = 0.$$

The bordered Hessian is given by the following determinant:

$$\begin{vmatrix} EU''(\theta F^{K-r})^2 + EU'\theta F^{KK} & EU''(\theta F^{K-r})(\theta F^{L-w}) + EU'(\theta) \theta F^{KL} & 0 \\ EU''(\theta F^{K-r})(\theta F^{L-w}) + EU'\theta F^{KL} & EU''(\theta F^{L-w})^2 + EU'\theta F^{LL} & -w \\ 0 & -w & 0 \end{vmatrix}$$

and is equal to

$$-w^2 [EU''(\theta) (\theta F^{K-r})^2 + EU'(\theta) \theta F^{KK}] > 0$$

By taking the total differential and using Cramer's Rule, we may find how K^c and L^c vary with the exogenous parameters (\hat{L} , M , A), and then use the equation

$$\frac{\partial (L/K)}{\partial \cdot} = \frac{\frac{\partial L}{\partial \cdot} K - \frac{\partial K}{\partial \cdot} L}{K^2}$$

to derive how the labor-land ratio changes (where the dot represents either of the three exogenous parameters). For example, we have the following matrix system

$$\begin{bmatrix} EU''(\theta F^{K-r})^2 + EU'\theta F^{KK} & EU''(\theta F^{K-r})(\theta F^{L-w}) + EU'(\theta) \theta F^{KL} & 0 \\ EU''(\theta F^{K-r})(\theta F^{L-w}) + EU'\theta F^{KL} & EU''(\theta F^{L-w})^2 + EU'\theta F^{LL} & -w \\ 0 & -w & 0 \end{bmatrix}$$

$$\begin{bmatrix} \partial K / \partial \hat{L} \\ \partial L / \partial \hat{L} \\ \partial \beta / \partial \hat{L} \end{bmatrix} = \begin{bmatrix} -EU'' (\theta F^{K-r}) w \\ -EU'' (\theta F^{L-w}) w \\ -w \end{bmatrix}$$

from which we may derive how the ratio L^c/K^c changes for small changes in \hat{L} . The expression is as follows:

$$\begin{aligned} \frac{\partial (L/K)}{\partial \hat{L}} &= \frac{-w^2}{|H|K^2} [wLEU'' (\theta F^{K-r}) + LEU'' (\theta F^{K-r}) (\theta F^{L-w}) + LEU' \theta F^{KL} \\ &\quad + KEU'' (\theta F^{K-r})^2 + KEU' \theta F^{KK}] \end{aligned}$$

Simplifying, we get

$$\frac{\partial (L/K)}{\partial \hat{L}} = \frac{-w^2}{|H|K^2} [LEU'' (\theta F^{K-r}) (\theta F^L) + KEU'' (\theta F^{K-r})^2]$$

Now, from the first order condition we may define

$$\theta^* = \frac{EU'(\cdot) \theta}{EU'(\cdot)} = \frac{r}{F^K}$$

That is, $r = \theta^* F^K$, and substituting this into the equation, we have

$$\frac{\partial (L/K)}{\partial \hat{L}} = \frac{-w^2}{|H|K^2} [LF^K F^L EU'' (\theta - \theta^*) \theta + K(F^K)^2 EU'' (\theta - \theta^*)^2] > 0$$

The second term in the brackets is negative. Srinivasan has shown that under non-decreasing relative risk aversion the first term is negative, so the whole expression is positive. Similarly, we have

$$\frac{\partial (L/K)}{\partial A} = \frac{-w}{|H|K^2} [LF^K F^L EU'' (\theta - \theta^*) \theta + K(F^K)^2 EU'' (\theta - \theta^*)^2] > 0$$

which differs from the expression for changes in \hat{L} by the absence of the wage term. Both assets and labor have the same effects of relaxing the financing constraint and making the farmer less averse to risk. Finally, we have

$$\frac{\partial (L/K)}{\partial M} = \frac{-w^2 L}{|H|K^2} [rF^K EU'' (\theta - \theta^*)] < 0$$

where the term in brackets is negative under decreasing absolute risk aversion.

Thus increases in land lead to decreases in the labor-land ratio, while increases in labor endowments or assets increase the ratio. As a farmer's wealth increases, the necessity of laboring to earn wage income decreases, and more labor is used in cultivation. The wealthy farmer will also devote more land to risky cultivation. Since the financing constraint meant that the farmer already was using too little labor, relaxing it will lead to relatively more labor than land being added, and the farmer ends up with a higher labor-land ratio.

A Positive Relation Between Wealth and Yields in Western Sudan

Demonstrating that a positive relation is theoretically plausible is important because it might explain why data from farm-level surveys in Sheikan district in western Sudan exhibit a positive relation between wealth and yields. The past decades in Sheikan have seen little

change in the technology of agricultural production. The main tool of cultivation remains the centuries-old *hashasha*, a long-handled hoe. Agriculture is extensive and rainfed, with farmers growing "traditional" crops (sorghum, millet, groundnuts and sesame). In general, farmers do not ridge, apply fertilizer or manure, plant hybrid seed, or use animal traction. Only a handful plow with tractors. Extension services and agricultural research programs have had limited impact. Few adult farmers have attended school.

Given this rudimentary technology, there seems to be little reason why poor farmers could not replicate the cultivation strategy of wealthier farmers, perhaps on a smaller scale. But they do not. The first column of table 2 shows that the value of production per *mukhammas* (roughly equivalent to a hectare) on the fields of wealthy households is almost twice as high as that on the fields of poorer households. Two different data sets are used: the first is a survey of Bireka village, the second a survey of 116 households in four village clusters to the south of Bireka around the market town of Jaibat. Both surveys were conducted in the fall of 1990. The unit of analysis is a "farm management unit", which typically corresponds to nuclear families.

The differences in average value were not due to a crop composition effect. Yields of virtually all crops were lower for poorer farmers, and there were no significant differences in the percentage of each farmer's land allocated to different crops (60% grain, 10% groundnuts, 20% sesame).

Can these differences in yields be explained using the typology developed above? Table 2 presents summary statistics of the land, labor, and wealth endowments that the theoretical discussion suggests would be important in determining labor-land ratios (and hence

yields). The average ratio of land owned to family labor is roughly 2:1 for poorer households, and 4:1 for wealthy households (note that this average ratio is different from the ratio of the averages reported in the table). After entering into factor markets, however, the ratio changes dramatically. Poorer farmers rent only 1.68 *mukhammas*, but hire themselves out to work slightly more than that; so labor availability for cultivation diminishes while the available land increases. The average ratio increases to 6:1, if one assumes that one family laborer works five *mukhammas*. Meanwhile, the average ratio for wealthy households falls to 3:1, as more labor is hired than land is rented. For the Jaibat sample the ratios change similarly, though the measure of land owned is biased because data on land rented out was not collected.

The first column of table 3 presents the results of a regression using these variables to explain the average value of yields per *mukhammas* for Bireka households. The explanatory variables included are as follows: dummy variables *POOR* and *RICH* that sort poorer and wealthier families according to overall assets positions, with an excluded category of middle households (families were sorted by the author, who had lived in the village for 14 months- the measure of assets for the Jaibat sample gives some idea of the disparities in wealth that made this categorization not problematic); the endowment of land owned *OWNLAN*, measured in *mukhammas*; the stock endowment of family labor *OWNLAB*, measured as the number of adults and children, where younger children (ages 10-15) are counted as one-third of an adult; a proxy for subsistence requirements *YGCHILD* that is the number of children under ten years of age.

While the *POOR* dummy is negative and significant, and of quite large magnitude, the overall explanatory power is low. A finer measure of land endowments is needed; an increase

in the endowment of high quality land makes the household wealthier, and hence more inclined to cultivate high quality land (which is, by the assumption of multiplicative risk, more risky). In addition, we should control for possible ethnic and gender differences in access to markets. Column 2 of table 3 reports an expanded regression including dummy variables for whether the household head is a woman *FEMALE*, a member of the *BURGO* ethnic group or a member of the more recent immigrants from Nigeria, *HAUSA*, and four variables representing the amount of owned land in different local categories (*OLDCLAY* is soil that is very high in clay as opposed to the sandy *goz* soils that are the most common soiltype; *OLDNAGA* is hard, compacted soil viewed as of poor quality; *OLDBURA* refers to soil that has lain fallow for at least one season, most commonly for five to ten years; *OLDKHUR* refers to fields along the seasonal water-courses where water retention is higher and soils have more organic matter, but which are more prone to weeds).

The inclusion of these ethnicity, gender and quality variables improves the fit of the regression. Three of the land quality variables are significant. The *POOR* dummy has increased slightly in magnitude, while the rich dummy is now positive and significant, indicating that on average poorer farmers owned soil-types that yielded higher value per hectare. Despite this correlation, the regression shows quite clearly that wealthier farmers had higher value per hectare than did poorer farmers.

Performance of Markets in Sheikan

How might we choose among the three tentative candidates for explaining the positive relationship in western Sudan between yields and farmer wealth? The three have distinct

implications for agrarian policy in terms of intervention in land tenure, insurance, or credit. A review of market performance in Sheikan casts doubt on relying on rental insecurity as an explanation, and supports the third model of credit constraints and the absence of insurance.

Land and Labor Markets

Land and labor markets in Sheikan appeared to function rather well. Local villagers and transient migrant labor working as hired labor accounted for one-third of all labor used in agriculture. Rented land also accounted for about one-third of all land cultivated. Transactions were not confined to intra-village rental; many villagers rented land from neighboring villages, sometimes travelling several hours to cultivate rented fields. Women participated in both labor and rental markets, though they received lower wages than men, and rented less often.

Neither hiring labor nor renting land seemed to be subject to high transactions costs, moral hazard, or adverse selection. In labor markets, the most direct evidence for this was that laborers were not supervised. Weeding with the long-handled *hashasha* hoe leaves defined rows of turned soil. Labor effort is easily monitored by visual inspection of the field. Moreover, the costs of supervising and motivating hired labor are, in all probability, not very different from the costs of mobilizing family labor. Grown-up sons are often in conflict with their fathers over the allocation of their labor time. The sons are interested in working for cash to accumulate bridewealth, or in working on their own small plots. Unmarried daughters work in local markets selling tea or processed food. Married women want to devote more time to their own fields rather than the household plots. There was no labor market dualism, where a wedge exists between the cost of hired labor and the cost of family labor.

In land rental markets, a widely shared opinion that renters could claim ownership of land did not impede widespread renting of land. The persistent power of traditional authorities in the area is why landowners did not fear dispossession to an inordinate degree. The central government in Khartoum had never been able to displace these local authorities, and in 1991 went so far as to devolve police, judicial and tax authority to the local leaders.

Following the work of Bliss and Stern and Benjamin, these assertions about the performance of labor and land markets can be verified by testing whether endowments of land and labor displace land rented and labor hired on a one-for-one basis. If they do, then the market may be said to perform well; if they do not- if for instance a lower endowment did not lead to an increase in market transactions- then presumably some market imperfection is impeding transactions.

The final two columns of table 3 report the results of regressions explaining net labor hired and net land rented for Bireka. *OWNLAN* is very close to minus one in the regression explaining net area rented; an extra unit of land means one less is rented, much as we would expect in a market that performed well. *OWNLAB* is significant and also negative in explaining net hired labor, though the magnitude is not as easy to interpret since *OWNLAB*, a stock variable, is being compared with *WEEDTOT*, a flow variable. (On average, households that did not hire or sell labor cultivated close to three *mukhammas* per member, quite a bit more than the regression coefficient.)

The dummy variables for poor and wealthy households are significant, suggesting that credit or insurance market imperfections spill over into the land and labor markets, limiting the extent to which households engage in land and labor hiring. The regression includes two terms

where land and labor endowments are interacted with the dummy variable for whether the household was poor (*POORLAN* and *POORLAB*). The significant positive coefficients on *POORLAB* indicate that poorer households do not, or are not able to, reach optimal factor ratios through market transactions. The smallest poor households are, perversely, the ones whose members work the most for others. Heads of large, poor families may prevent other household members from working for wages, controlling their labor by having them work on the family farm. Similarly, in the land rental regression, smaller poor households are more influenced by family size in making their rental decisions. Again, poor household heads may try to control household labor by cultivating larger areas, and perhaps larger poor families maintain their community status and access to land by cultivating larger areas.

Credit and Insurance Markets

While most households are thus able to use land and labor markets to move towards an optimal labor-land ratio, the incentives that determine their optimal ratios are distorted by difficulties in obtaining credit and insurance. Both of these markets perform poorly. The traditional institution of informal agricultural credit, a crop mortgage known as *sheil*, has disappeared under the weight of increasing risk of drought, more lucrative profits in trading and speculation, and a hostile and uncertain legal and juridical situation. Borrowing is now limited to emergency consumption and marriage loans between close kin and neighbors, or trade credit. Loans are invariably at zero interest. In the 1989 season in Bireka local traders extended only a handful of loans. In 1990 there were no such loans, and the villagers even refused to borrow from the Agricultural Bank of Sudan cooperative lending program, fearing that the Bank would

enforce repayments harshly by confiscating assets. There was no informal "market" for credit, such as one might find in Asia, with well-recognized moneylenders and terms of borrowing.

The limited extent of consumption borrowing and reciprocity was evident toward the end of 1990 when the local economy suffered a severe crisis caused by a drought that led to complete crop failure, sharp rises in the price of grain, and a drying up of employment opportunities. This borrowing was exceptional, in the eyes of most villagers, and there were no "formal" conditions or terms for the loans; many borrowers indicated they would in all likelihood not repay. No villager ever disagreed with the notion that a household was cushioned against idiosyncratic shocks only by the charity of friends and relatives. Moreover, while most households reduced their consumption dramatically, and children of poor households became malnourished, and men migrated from the village in search of work, leaving their wives and children on reduced budgets, other households maintained their earlier standards of living. Indeed, a few households were undertaking new productive ventures such as establishing irrigated gardens and investing in livestock. Such disparities are not predicted by the perfect insurance model, where individual income should follow aggregate income. Consumption borrowing and informal reciprocal insurance could not be said to approximate "full-insurance".

Conclusion

This paper developed a typology of the relations between endowments of land, labor and wealth, and the production strategies of farmers (summarized by the labor-land ratio). Previous literature concentrated on the inverse relationship, but this typology and the data from Sheikan

show that researchers should consider the possibility and implications of positive relationships. Such relationships are likely to arise in settings where households have limited access to financing and reciprocal insurance, and where landlords are reluctant to rent out land for fear of losing property rights. These settings are as common as the labor market dualism invoked to explain the inverse relationship.

While the inverse relationship continues to inspire optimism for those who believe that an expanding small-scale farm sector facilitates the development process, it fails to explain why the reverse is usually observed. Why do the poorest farmers get marginalized so easily? This paper suggests that one reason is that financial market imperfections lead poorer farmers to adopt less profitable, extensive strategies of cultivation. Over the long term the disparities in wealth grow. When the state creates a land market, or as one gradually evolves, the poorer farmers sell their land and the larger farmers expand. In dealing with this problematic situation, important policy decisions must be made: how to best support NGO small-scale financial programs, how to restructure agricultural credit banks, how best to tie credit with input extension, and how to strengthen and decentralize authority to local institutions that share and spread risk. Exciting new insights into these policy issues have appeared over the last decade, giving room for a different, more cautious, optimism.

References

- Bardhan, P.K. "Productivity and Returns to Scale: An Analysis of Farm-level Data in Indian Agriculture." *J. Polit. Economy*, 81 (November/December 1973):1370-86.
- Benjamin, D. "Household Composition, Labor Markets and Labor Demand: Testing for Separation in Agricultural Household Models" *Econometrica*, 60 (March 1992): 287-322.
- Benjamin, D. "Can Unobserved Land Quality Explain the Inverse Productivity Relationship?" Department of Economics, University of Toronto, mimeograph, 1992.
- Berry, R. and W. Cline. *Agrarian Structure and Productivity in Developing Countries* Baltimore: The Johns Hopkins University Press, 1979.
- Bhalla, S, and P. Roy. "Mis-Specification in Farm Productivity Analysis: The Role of Land Quality." *Oxford Economic Papers*, 40(March 1988):55-73.
- Binswanger, H., K. Deininger and G. Feder. "Power, Distortions, Revolt and Reform in Agricultural Land Relations." *Handbook of Development Economics*, Volume II, Jere Behrman and T.N. Srinivasan, eds. (North Holland, forthcoming).
- Bliss, C., and N. Stern. *Palanpur: The Economy of an Indian Village* (Oxford: Clarendon Press, 1982).
- Carter, M. "Risk, Reciprocity and Conditional Self-Insurance in the Sahel: Measurement and Implications for the Trajectory of Agricultural Development in West Africa." Dept. of Ag. Econ., Univ. of Wisconsin-Madison, mimeograph, 1991.
- Carter, M. and K. Wiebe. "Access to Capital and Its Impact on Agrarian Structure

- and Productivity in Kenya." *Amer. J. of Agr. Econ.*, 72(December 1990):1146-50.
- Eswaran, M. and A. Kotwal. "Access to Capital and Agrarian Production Organization." *The Economic Journal*, 96(June 1986):482-498.
- Feder, G. "The Relation Between Farm Size and Farm Productivity: The Role of Family Labor, Supervision and Credit Constraints." *J. of Develop. Econ.*, 18(May/June 1985):297-313.
- Grimard, F. "Household Consumption Smoothing Through Ethnic Ties: Evidence from Côte d'Ivoire." Dept. of Econ., Princeton University, mimeograph, 1992.
- Morduch, J. "Risk, Production, and Saving: Theory and Evidence from Indian Households." Dept. of Econ., Harvard University, mimeograph, 1992.
- Rosenzweig, M. "Risk, Implicit Contracts and the Family in Rural Areas of Low Income Countries." *The Economic Journal*, 98 (December 1988):1148-70.
- Rosenzweig, Mark, and Hans Binswanger. "Wealth, Weather Risk and the Composition and Profitability of Agricultural Investments." *The Economic Journal* 103 (January 1993) 56-78.
- Sen, A. "Peasants and Dualism With or Without Surplus Labor." *J. Polit. Econ.*, 74 (June 1966):425-50.
- Srinivasan, T.N. "Farm Size and Productivity: Implications of Choice Under Uncertainty." *Sankhya: The Indian J. of Stat.*, Series B, 34 (Dec. 1972):409-420.
- Swamy, A. "Efficiency Wages, Capital Constraints, and Resource Allocation in an Agrarian Economy: The Case of Colonial Punjab, c. 1933-36." Dept.

of Econ., Northwestern University, mimeograph, 1991.

Townsend, R. "Risk and Insurance in Village India." *Econometrica*, 62(May 1994):539-592.

Udry, C. "Risk and Insurance in a Rural Credit Market: An Empirical Investigation in Northern Nigeria." *Rev. of Econ. Stud.* 61(July 1994): 495-527.

White, H. "A Heteroskedasticity Consistent Covariance Matrix and a Direct Test for Heteroskedasticity." *Econometrica* 48 (May 1978): 817-38.

Wiens, T. "Uncertainty and Factor Allocation in a Peasant Economy." *Oxford Economic Papers*, 29(March 1977):48-60.

Abstract

AGRARIAN STRUCTURE AND AGRICULTURAL PRACTICE: TYPOLOGY AND APPLICATION TO WESTERN SUDAN

Michael Kevane

A typology of models explaining patterns of variation in farm endowments and farm practices and yields shows that insecurity in renting land, financing constraints and the absence of insurance generate patterns of factor use quite different from the famous 'inverse relationship' caused by labor supervision problems. One might expect to observe positive relationships between wealth and yields. Village-level data from western Sudan confirm that such positive relationships are not a theoretical curiosity. Wealthy farmers have higher levels of output per hectare because they use more labor per hectare. Insurance and financing constraints appear to be the crucial market failures.

Key words: agrarian structure, rural credit, labor, small farmers, Sudan

