Credit Frictions and Mis-Allocation in Agriculture

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Agriculture in LDCs: Types of Farms

- Agriculture in LDCs strikingly different from that in DCs with regard to size of farms, technology and organization (e.g., Ray (1998, Chapter 12.4)):
- In LDCs (with few exceptions):
  - small farms predominate, cultivated mainly by family labor (esp Asia)
  - mostly owner cultivated (world-wide average 79% of farms, 61% of area)
  - some tenancy or owner-cum-tenancy (17% of farms, 36% of area); including communally owned land in Africa and China
  - small farms are more labor-intensive, and less mechanized
  - large farms more important in Latin America (more than 75% area accounted by farms exceeding 50 hectares); professionally or owner-managed, plantations, haciendas etc
- Larger farm size in DCs (US: 161 ha.; Asia: 2.3 ha.), highly mechanized, hired labor, increasingly owned by agri-corporations

Mis-Allocation: Efficiency Implications

- Huge variations in farm productivity across countries (90:10 percentile difference in output per worker in agriculture is 45:1, compared to 4:1 for non-agriculture)
- Also large variations in productivity across farms *within* countries, suggesting mis-allocation owing to market or policy-based distortions
- Pro-market economists argue most distortions are policy-based, owing to regulations (eg land ceilings, entry restrictions, preferential subsidies for small farmers etc)
- Pro-intervention advocates argue these variations across farms of differing sizes reflect market failures, that ought to be corrected by state policy (eg land reform, land ceilings, tenancy regulation etc)

Inequality Implications

- Land policy also has huge inequality implications: land inequality is much larger in Latin American countries (Gini above .8) than Asia (Gini range .4-.55) owing to differing importance of large farms
- Pro-intervention camp point to high land inequality under laissez faire or colonial pro-landlord states, generating high economic inequality, poverty, civil war, revolutions etc
- Pro-market economists either silent on inequality issues, or argue that land regulations are not in the best interest of the rural poor (eg impedes rural-urban migration, lowers per capita income in LDCs)

Stylized Facts concerning LDC Agriculture

- 'Agrarian Class Structure': how nature of productive work varies with land owned across households:
  - *Landless Proletariat:* Poorest households are landless agricultural workers
  - *Marginal Landowners:* Those owning small plots, cultivating them using family labor, supplemented by working outside
  - *Middle Class/Peasants:* Intermediate size farms employ only family labor, or mix of family and hired labor; do not work for others
  - *Landed elites:* Large farms employ only hired labor, with owners either managing/delegating to professional managers (haciendas/plantations) or leasing out their land (landlords)

Farm Size-Yield Relationship in LDCs, contd.

- Inverse Size-Yield Relationship: Larger the farm, higher is the land-labor ratio, and higher is farm yield (per acre)
- Large:small farm yield ratio ranging from 14:1 in India, 6:1 in Brazil, 2.7 in Pakistan to 1.5:1 in Malaysia (Ray 1998, Tables 12.6-12.7)
- Suggests land redistribution from large to small farms would reduce inequality *and* raise agricultural productivity!
- Subject to many econometric critiques (measurement error, unobserved heterogeneity/endogeneity, functional form etc), but nevertheless is robust
- Next session: recent empirical study of Foster-Rosenzweig (2017) with Indian data, argues size-productivity relation is U-shaped (thus explaining both within-country and across-country productivity differences)

A Mis-allocation model based on market failures

- Eswaran-Kotwal (1985) show these facts can be explained by a model of credit-cum-labor market frictions
- Credit market friction: credit rationing; credit limits increase in land owned
- Labor market friction: hired workers are subject to moral hazard (shirking), so need to be supervised
- Model abstracts from economies of scale (Foster-Rosenzweig incorporate these to generate the U-shape)

Eswaran-Kotwal Model: Assumptions

- One good produced using two inputs: land (H), labor (L); (abstract from capital, or suppose land and capital used in fixed proportions)
- CRS technology $F(H, L)$, smooth, strictly quasi-concave
- Small fixed cost k to operate a farm
- All households have single unit of labor endowment, vary with regard to land endowment ($\bar{h}$); positive mass of households have no land
- Common quasi-linear utility function of all households $Y + U(R)$ where Y is income and $R \in [0, 1]$ is rest/leisure, U is strictly increasing, st. concave, Inada

Land (tenancy), Labor, Credit Markets

- Households can engage in local markets for (leasing) land and (hiring) labor, take market prices v, w as given
- Hired labor needs to be supervised: time taken to supervise L hours is $s(L)$, smooth, strictly increasing, st. convex, with $1 > s'(0) > 0$
- h is land leased in (negative means leased out); $l \geq 0$: own-labor, $L \geq 0$: hired labor
- Inputs paid in advance; farm working capital needed: $w(L - t) + vh$
- Credit constraint: $w(L - t) + vh \leq B(\bar{h})$, where $B(.)$ is credit limit, smooth, strictly increasing, $B(0) = 0$

Household Decision Problem

- Household owning land $\bar{h}$ decides (given prevailing prices w, v and setup cost k) whether to operate a farm; if yes, selects h, l, t, L to maximize

$$F(\bar{h} + h, L + l) - w(L - t) - vh + U(1 - l - t - s(L)) \qquad (1)$$

- subject to credit constraint:

$$w(L - t) - vh \leq B(\bar{h}) \qquad (2)$$

- Equilibrium: Land and labor markets clear

Benchmark Case: No Credit Constraint

If there is no borrowing constraint, household faces unconstrained maximization problem, which can be reformulated (with $H \equiv \bar{h} + h$):

$$\max_{H,l,L,t} F(H, L + l) - w(L - t) - v(H - \bar{h}) + U(1 - l - t - s(L)) \qquad (3)$$

Benchmark Case: No Credit Constraint

Proposition

In the absence of any borrowing constraint, if fixed cost k is small enough, competitive equilibrium will satisfy:

(a) all farms have the same size, choose the same inputs, and produce the same output

(b) the labor market shuts down

(c) every farm is productively efficient ($\frac{F_H}{F_l} = \frac{v}{w}$)

(d) every household selects same level of rest ($U'(R^*) = w$), those with more land earn more income (through leasing) and so have higher utility

Proof Outline

- All households have effectively the same objective function $F(H, L+I) - w(L-t) - v(H-\bar{h}) + U(1-I-t-s(L))$, differs only by lump-sum $v\bar{h}$
- Common farm surplus (excluding fixed cost and rental income $v\bar{h}$): $F(H, L+I) - w(L-t) - vH + U(1-I-t-s(L))$
- U is strictly concave, so there is a unique optimum value of $R = R^* = 1 - I - t - s(L)$
- If labor market is active, t positive for some hh (hence $U'(R^*) = w$), L positive for some hh
- Hence hired labor cost $F_L = w + U'(R^*)s'(L) = w[1 + s'(L)] > w$, own-labor cost, so hh would do better to replace hired with own labor
- So every farm only employs own-labor: (H, I) maximizes $F(H, I) - vH + U(1-I)$, which must have a unique solution

Re-Introduce Credit Constraint

- Bring the credit constraint back
- For $\bar{h}$ large enough, the constraint will not be binding: the credit limit is large enough to cover working capital needs in the unconstrained solution
- For $\bar{h}$ small enough, the credit limit is nearly 0 so the constraint will be binding: $w(L-t)+v(H-\bar{h})=B(\bar{h})$
- For constrained households, area cultivated is determined by labor supply decisions: $H=\bar{h}+\frac{1}{v}[B(\bar{h})-w(L-t)]$
- Their objective reduces to

$$F(\bar{h}+\frac{1}{v}[B(\bar{h})-w(L-t)],l+L)-B(\bar{h})+U(1-l-t-s(L)) \quad (4)$$

Landless and Marginal Landowners

- If $\bar{h}$ is close enough to 0, farming is feasible only if the hh works on the labor market to finance working capital needs: $t > L \geq 0$, implying $F_H \frac{w}{v} = U'(R)$
- Such households will not hire in any workers ($L = 0$), because this is more costly ($F_H \frac{w}{v} + U'(R)s'(L)] = U'(R)[1 + s'(L)]$) than family labor ($U'(R)$)
- So (conditional on deciding to operate a farm) they must work on their own farm: $l > 0$, implying $F_l = U'(R)$
- Smallest farms satisfy the same efficiency conditions as in the first-best: $F_H \frac{w}{v} = F_l = U'(R)$, determining t, l

Rural Proletariat: the Poorest Class

- Farm operating profits rising in $\bar{h}$
- If fixed cost k exceeds operating profits of landless, there will exceed a threshold $\bar{h}_1$ below which a hh will not operate a farm — the proletariat
- They lease out whatever land they have to earn some rent (*reverse tenancy*), and work on the labor market

Lower Middle Class: Marginal Farm Owners

- At and above the threshold, a household will operate a farm — the smallest (viable) farms, satisfying the same efficiency conditions as in the first-best (same $\frac{t}{l}, F_H, F_l$ and farm yield)
- Such households may supplement income from farms with earnings from the labor market ($t > 0$), and not hire in any workers.

Lemma

If marginal farm owners work on the labor market, those with (slightly) more land operate larger farms, supply less labor to the market and more to their own farm, use the same ratio of land to labor, achieve the same (first-best) yield and rest.

- *Proof:* Rest is fixed by $\frac{w}{v} F_H = U'(R)$. So t and l move in opposite directions. As $\bar{h}$ rises, farm size must rise (otherwise t falls, l rises and land labor ratio falls). So farm size rises, l rises, t falls.

Middle Class: Self-Sufficient Farm Owners

- Among marginal farm owners, t is falling in $\bar{h}$, so there is a threshold $\bar{h}_2 > \bar{h}_1$ at which $t(\bar{h}_2) = 0$, with $t(\bar{h}) > 0$ for all $\bar{h} < \bar{h}_2$.
- For $\bar{h}$ in a right neighborhood of $\bar{h}_2$, the hh is self-sufficient:
  - does not work on the labor market $(t(\bar{h}) = 0)$
  - does not hire in any workers $(L = 0)$
- Choose l to maximize $F(\bar{h} + \frac{B(\bar{h})}{v}, l) + U(1 - l)$

Lemma

Self-sufficient farm owners rest less than marginal farm owners, apply less labor per acre, and achieve lower yields.

- *Proof:* As $\bar{h}$ rises, farm size rises, l rises, rest $1 - l$ falls, shadow cost of family labor $U'(R)$ rises, F_l falls, land labor ratio rises, farm yield per acre falls

Upper Middle Class: Owners of Farms using Family and Hired Labor

Lemma

There exists threshold $\bar{h}_3 > \bar{h}_2$ such that in a right neighborhood of $\bar{h}_3$ farm owners hire in some workers besides supplying their own labor, and achieve lower yields compared to self-sufficient farms.

Argument:

- Among self-sufficient farmers, increases in $\bar{h}$ result in less rest and rising shadow cost $U'(R)$ of family labor
- marginal cost of hired labor $\frac{w}{v}F_H + U'(R)s'(0)$ rising at a slower rate (since $s'(0) < 1$)
- So at some $\bar{h}_3$, marginal cost of hired labor equals own labor cost, so beyond $\bar{h}_3$ the owner hires in workers
- cost of labor higher than self-sufficient farms, so yields are lower

Elites: Owners of Farms using Hired Labor only

- Among upper middle class, increasing $\bar{h}$ associated with substitution of hired labor for own labor (since marginal cost of former rises less slowly)
- There exists threshold $\bar{h}_4 > \bar{h}_3$ such that at and above $\bar{h}_4$ the owner no longer works on own farm, and (only) supervises hired workers — rural elites.
- *Inverse size productivity relationship:* Above $\bar{h}_1$, rising $\bar{h}$ raises marginal cost of labor, lowering land-labor ratio and yield per acre