Land Reforms and Population Growth

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Contents

Agents

- One good, the price of which is normalized at unity.
- the representative *peasant family*, which
  - produces the good from land and labor,
  - derives utility from its consumption, the number of its children and from its social status determined by its wealth relative to the other peasant families, and
  - invests in agricultural technology to improve the productivity of the land it cultivates.
- the representative *landowner*, which consumes all of its rents it collects from the peasant family.

Sharecropping

- The landowner rents a farm out to the peasant family taking a share of the crop as a return.
- The interaction of these agents is an extended game:
  1. The landowner attempts to monitor the peasant family with costs.
  2. The peasant family hides some of its crop from the landowner with costs.

  This game is solved in reverse order.
- In the equilibrium of this extended game, the peasant family earns a fixed proportion α of its crop Y:

$$\alpha = \begin{cases} 1 & \text{as an independent farmer,} \\ \gamma \in (0,1) & \text{as a tenant farmer.} \end{cases}$$

Population dynamics

- The peasant family has $L(t)$ members at time t. Its (net) fertility rate n is

$$n \doteq \frac{\dot{L}}{L} \doteq \frac{1}{L}\frac{dL}{dt},$$

where $(\dot{\ })$ is the time derivative.

- The family improves the productivity of land, A, by its investment I:

$$\dot{A} \doteq \frac{dA}{dt} = I.$$

- We normalize the area of land at unity, so that the input of efficient land equals A.

Production technology

- The number of family members employed in child rearing, qnL, is in fixed proportion q to total fertility nL at any time. The rest of the family,

$$N \doteq L - qnL = (1 - qn)L,$$

works in the family farm.

- The composite product Y is made from labor input N and efficient land A according to the linearly homogeneous production function

$$Y = F(N, A), \quad F_N \doteq \frac{\partial F}{\partial N} > 0, \quad F_A \doteq \frac{\partial F}{\partial A} > 0, \quad F_{NN} \doteq \frac{\partial^2 F}{\partial N^2} < 0,$$
$$F_{AA} \doteq \frac{\partial F}{\partial A^2} < 0, \quad F_{NA} \doteq \frac{\partial^2 F}{\partial N \partial A} > 0.$$

Land reform

- A land reform increases the family's crop share α from γ to 1.
- In return, the landowner's lost wealth is compensated by a debt which the family repays over time.
- We assume that if a family is split into smaller families, then its debt is divided in proportion to family members. This allows us to define the debt in per capita terms.
- We furthermore assume that a fixed proportion β of per capita debt b will be repaid at each time, for simplicity:

$$\dot{b} = -\beta b.$$

Initial debt

- Per capita output at time t is $Y(t)/L(t) = F\big(1 - qn(t), a(t)\big)$.
- The landowner's rate of time preference is a constant σ.
- On the assumption that the economy is in the steady state at time $t = 0$, the present value of the landowner's per capita output is $F(1 - qn_0, a_0)/\sigma$, where

$$a_0 \doteq \lim_{t \to 0-} a(t), \quad n_0 \doteq \lim_{t \to 0-} n(t),$$

  are the predetermined values of a and n at time $t = 0$.
- Of the present value of output, $F(1 - qn_0, a_0)/\sigma$, the landowner forfeits the proportion $\alpha - \gamma$, if a land reform increases the peasant family's crop share α at time $t = 0$.
- Because the family compensates this loss to the landowner as a debt, the initial value for per capita debt $b(t)$ is

$$b(0) = (\alpha - \gamma)F(1 - qn_0, a_0)/\sigma.$$

Investment in productivity

- The family spends its income αY on consumption C, investment I and repayments βbL of debt bL. Denoting consumption per capita by $c \doteq C/L$ and the productivity of land per capita by $a \doteq A/L$, the family's budget constraint becomes

$$\dot{A} = I = \alpha Y - C - \beta bL = [\alpha F(1 - qn, a) - c - \beta b]L.$$

- We obtain the per capita budget constraint

$$\dot{a} = \frac{\dot{A}}{L} - \frac{\dot{L}}{L}\frac{A}{L} = \frac{\dot{A}}{L} - na = \alpha F(1 - qn, a) - c - \beta b - na.$$

Temporary utility

- The family derives temporary utility from the per capita consumption and the proportion of young in the family, n (= the fertility rate), which characterizes the status provided by children in a rural society.
- A single family has the higher status, the higher input of efficient land per capita it has (i.e. the higher $a \doteq A/L$) relative to that among all families on the average, $\underline{a}$. Thus, we augment the temporary utility by an increasing and concave function $v(a - \underline{a})$ of the difference $a - \underline{a}$.
- The temporary utility is therefore given by

$$u(t) = \log c + \theta \log n(t) + \varepsilon v\big(a(t) - \underline{a}(t)\big),$$

where $\theta > 0$ and $\varepsilon > 0$ are the constant weights for children and status.

The optimal plan

- The peasant family's rate of time preference is a constant $\rho > 0$.
- The peasant family maximize its expected discounted utility at time $t = 0$,

$$U = \int_0^\infty u(t)e^{-\rho t}dt = \int_0^\infty \left[\log c + \theta \log n + \varepsilon v(a - \underline{a})\right] e^{-\rho t}dt,$$

by its fertility n and per capita consumption c subject to its budget constraint and the repayment of debt;

$$\dot{a} = \alpha F(1 - qn, a) - c - \beta b - na, \quad \dot{b} = -\beta b.$$

- Solving this problem by maximum principle, we obtain a system of four equations with two state and two co-state variables. Because there are two stable and two unstable roots, there is a saddle point solution.

The long-run effect of a land reform 1

- We examine now the effect of a land reform on the steady-state equilibrium of the system.
- First, we consider the effect of α on the assumption that $\alpha \in [\gamma, 1]$ is a continuous variable. The reform increases both the crop share α and the initial debt for the family at time $t = 0$.
- If the desire to accumulate wealth relative to desire to have children, $\frac{\varepsilon}{\theta}$, is high and the repayment rate of the debt, β, is slow, we obtains the result:

Proposition

In the long run, a marginal increase of the peasant family's crop share α increases per capita efficient land a^*, but decreases the fertility rate n^*.

The long-run effect of a land reform 2

Because this result holds for all values $\alpha \in [\gamma, 1]$, it can be generalized for the discrete choice $\alpha \in \{\gamma, 1\}$ as well:

Proposition

In the long run a land reform, where a tenant farmer with $\alpha = \gamma < 1$ becomes an independent farmer with $\alpha = 1$, increases per capita efficient land a^*, but decreases the fertility rate n^*.

Interpretation: An increase of the crop share α raises the rate of return for investment in land. This promotes the family's incentives to transfer resources from child rearing to investment in land.