Risky Agriculture, Farm Earnings, and Development

Preliminary

Antonio Ciccone
ICREA-UPF
Economic Development as Structural Transformation

What determines whether this transformation takes place or not?
Determinants of Structural Transformation

-- Policy barriers
  - barriers to moving resources to manufacturing;
  - barriers that inhibit manufacturing growth

-- Productivity levels in agriculture (Murphy, Shleifer, Vishny QJE 1988; Matsuyama JET 1992)

-- Income distribution (Murphy, Shleifer, Vishny QJE 1988)

-- ...

-- ADDED HERE: Agricultural risk (soil, weather, crop diseases…)
Dual Economy

-- Agriculture
- “technologically backwards”
- “decreasing returns”
- “low earnings/ productivity”

-- Manufacturing
- “modern”
- “increasing returns/ learning-by-doing”
- “high earnings/ productivity”

Duality sustained by policy barriers
Dual Economic Development

Earnings/productivity differentials are sustained by policy barriers
Dual Nobel Prize Winners

Arthur Lewis

Theodore W. Schultz

1979 Nobel Prize for work between late 1940s and early 1960s
The main characteristic of Schultz's studies in agricultural economics is that he does not treat agricultural economy in isolation, but as an integral part of the entire economy.

Schultz's analytical interest has been focused on the imbalance between relative poverty and underdevelopment in agriculture compared with the higher productivity and the higher income levels in industry [...].
Nobel Press Release: Arthur Lewis

-- [Lewis’] first model is based on the dual nature of a developing economy. There is an agricultural sector [...] primarily based on self-support [...] and a modern market-oriented sector primarily engaged in industrial production.

-- [...] the low productivity of agriculture is, in Lewis's analysis, a causal factor for the poverty of the developing countries and a restriction on growth [...].
Today’s Development Accounting Literature

-- average labor productivity in NON-AGRICULTURE is much greater than in AGRICULTURE in many poor countries
  (this observation appears to go back to Kuznets)

-- this could be an indication of barriers that, once removed, would lead to less dispersion in international incomes
  (e.g. Restuccia, Yang, Zhu JME forthcoming)
Data on y-axis for 1980s from PWT; on x-axis from WDI
View examined here

Could earnings differentials be sustained by aversion to risk of food consumption below some threshold?
Model

-- with 2 sectors: agriculture and manufacturing

-- households are free to move between sectors

-- households are avers to the risk of food consumption falling below some threshold
Can low agricultural productivity … lead to food (price) risk that give rise to a large earnings premium in the manufacturing sector (low farm earnings)?

→ low agricultural productivity could explain
  - large agricultural sectors
  - low farm earnings compared to manufacturing
Trade openness

-- the argument will require that domestic food prices are linked to the domestic supply of agricultural goods

→ maybe model most relevant as one of urbanization in “early civilizations”? 

→ but even as late as in the 1980s there are “closed economies” -- and they appear to have high productivity in NON-agriculture relative to agriculture
Real income per capita

Productivity NON-agric/agric in 1980s
(open/closed according to Sachs-Warner criterion)

- Open countries
- Closed countries
Model presentation outline

-- Household preferences

-- Production

-- Equilibrium
Household’s (non-homothetic) preferences: income and food & manufactures

income (manufacturing units)

spending on food

spending on manufactures

$pF$
Household preferences: aversion to food risk (I)
Household preferences: aversion to food risk (II)

INCREASE IN FOOD RISK AVERSION
High aversion to risk of food below $F$

-- Denote by $\mu$ the amount of manufactures households are willing to pay to eliminate food risk

-- Focus on the case of high $\mu$
Household preferences

\[ U = \begin{cases} 
\alpha q_a & \text{if } q_a < F \\
\alpha F + q_m & \text{otherwise}
\end{cases} \]

-- utility linear in manufacturing good once households have achieved \( F \) units of food

\( \Rightarrow \) will imply risk-neutrality w.r.t. manufacturing goods once \( F \) is ensured
Aversion to risk of food below $F$

$$\mu = \frac{\pi_L}{\pi_H} \alpha (F - q_\alpha (L))$$

-- as $\alpha$ becomes large, the aversion to food consumption below $F$ becomes large
A model with high and low agricultural productivity

-- in agriculture:
  - $A_L$ in state $L$ (probability $\pi_L$)
  - $A_H$ in state $H$ (probability $\pi_H$)

-- feasible to ensure food $F$ for everybody ($A_L > F$)

-- a household produces $M$ in the manufacturing sector (uncertainty would not matter)

-- must work in agriculture or manufacturing
Notation

-- $\lambda$ share of agricultural population

-- $\theta$ ratio of agricultural to manufacturing population ($\theta = \frac{\lambda}{(1-\lambda)}$)
Is there an equilibrium that ensures food $F$ for everybody?

\[
\begin{align*}
\hat{\lambda} &= \frac{F}{A_L} \\
\hat{\theta} &= \frac{F}{A_L - F}
\end{align*}
\]
Equilibrium price in good agricultural state ("excess food")

\[ p_H^* = 0 \]

-- at the allocation where everybody gets food \( F \) farmers are willing to supply food at price zero
Is there a price of food in state $L \ (p_L)$ that equalizes expected utils across sectors?

Expected utils in farming

$$W_{\text{farming}} = \alpha F + \pi_L (A_L - F) p_L$$
\[ \alpha F + \pi L M (A_L - F) / F \]
Expected utils in manufacturing

\[ W_{\text{manufacturing}} = \alpha F + \pi_H M + \pi_L \left( M - \hat{\theta}(A_L - F)\rho_L \right) \]

\[ = \alpha F + \pi_H M + \pi_L \left( M - F\rho_L \right) \]
NO-FOOD-SHORTFALL EQUILIBRIUM

\[ \alpha F + \pi_L M (A_L - F) / F \]

\[ \alpha F + \pi_H M \]

\[ \alpha F + M \]

Farmers

M-workers

\( p_L^* \)
FOOD SHORTFALL IN LOW-PROD STATE

\[ \alpha F + \pi_L M(\mathbf{A_L} - F)/F \]

\[ \alpha F + \pi_H M \]
NO-FOOD-SHORTFALL EQUILIBRIUM if & only if:

\[ \pi_L A_L \geq F \]
Agricultural population share
(for high aversion to risk of food below $F$)

Manufacturing share greater
where agricultural risk lower
FERTILE CRESCENTS
Farm earnings relative to manufacturing (in manufactures)

<table>
<thead>
<tr>
<th></th>
<th>Farmers</th>
<th>M-workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L$ state</td>
<td>$A_L p_L^*$</td>
<td>$M$</td>
</tr>
<tr>
<td>Expected</td>
<td>$\pi_L A_L p_L^*$</td>
<td>$M$</td>
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</tbody>
</table>
NO-FOOD-SHORTFALL EQUILIBRIUM: manufacturing wage premium

expected earnings
manufacturing/farming
Proof

\[ W^{\text{manufacturing}} = \alpha F + \pi_H M + \pi_L (M - Fp_L^*) \]

\[ = W^{\text{far min g}} = \alpha F + \pi_L (A_L - F)p_L^* \]

\[ \Rightarrow M = \pi_L A_L p_L^* \]
FOOD-SHORTFALL EQUILIBRIUM: manufacturing wage premium

\[ \theta^* < \hat{\theta} = \frac{F}{A_L - F} \]

\[ \theta^* \rightarrow \hat{\theta} \quad \text{as aversion to risk of food consumption below } F \text{ becomes large} \]
FOOD-SHORTFALL EQUILIBRIUM

\[ \theta^* \rightarrow \hat{\theta} = \frac{F}{A_L - F} \]

\[ \rightarrow \quad p_L^* = \frac{M}{(A_L - F)\theta^*} \rightarrow \frac{M}{F} \]
Farm earnings in $L$ state

$A_L p_L^* \rightarrow \left( \frac{A_L}{F} \right) M$

$\rightarrow$ when $A_L \approx F$

$\rightarrow$ farm earnings in $L$ state close to manufacturing earnings ($M$)
FOOD SHORTAGE EQUILIBRIUM: expected agricultural earnings

\[ \pi_L A_L p_L^* \rightarrow \pi_L \frac{A_L}{F} M \]

\[ \leq 1 \]

\[ \rightarrow \text{when } \pi_L \text{ small} \]

\[ \rightarrow \text{expected farm earnings low compared to manufacturing earnings} \]
Proposition 1

When there is a small probability that agricultural productivity is just above $F$, and aversion to risk of food consumption below $F$ is high, then:

-- farm earnings (in terms of manufactures) are 0 “most of the time”
-- farm earnings are just above manufacturing earnings “some of the time”
-- farm earnings are low compared to manufacturing earnings in expectation
The role of non-homothetic preferences

\[ U = V \left( q_a^\phi q_m^{1-\phi} \right) \quad 0 < \phi < 1 \]

\[ \lambda \gamma A_S + (1 - \lambda) \gamma \frac{M}{p_s} = \lambda A_S \quad -- \text{food market clearing} \]

\[ \rightarrow p_s A_S \quad \text{is independent of agricultural productivity} \]

\[ \rightarrow p_s A_S = M \]
Proposition 2

Equilibria where expected farm earnings are lower than expected manufacturing earnings are Pareto inefficient
Proof

Consider the allocation with:
(i) enough farmers to feed everybody $F$ in state $L$ \((\lambda = \hat{\lambda})\)
(ii) food/manufactures split equally among households

\[\Rightarrow \text{expected utils: } W = \alpha F + M (1 - \hat{\lambda}) = \alpha F + M \left(\frac{A_L - F}{A_L}\right)\]

expected utils
In competitive equilibrium: \(W^* = \alpha F + \pi_L (A_L - F) p_L^*\)

\[M > \pi_L A_L p_L^* \iff W > W^*\]
Policy

• Tax $M$-workers and subsidize farmers

• Government failure in poor countries? Can the government commit?

• Market (pre-tax/subsidy) earnings of $M$-workers would continue to be above farm earnings
A model with a continuous, uniform distribution of agricultural productivity
Endogenous small $\pi_L$

$\pi_L = \text{Probability of food shortage}$
As risk-aversion to food below $F$ becomes large
Conclusion

• when *aversion to risk* of food consumption below some threshold *high*
• and *agricultural productivity* in the worst state is *close to this threshold*

then

• *farm earnings very low compared to manufacturing most of the time*
• somewhat higher than manufacturing earnings in instances of very bad harvests
• *manufacturing better paid in expectation*
Long distance trade

- trade among identical countries with uncorrelated agricultural risk

→

- reduces food risk
- lowers agricultural population share
- increases manufacturing sector in all trading partners
The Mediterranean: cheap trade across weather zones?