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Long-term Growth and Secular Stagnation

Handout

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Why is Agricultural Productivity So Low in Poor Countries?
The Case of India

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Development Accounting Review

- Using $y = Ak^{\alpha}\left[hl\right]^{1-\alpha}$ to represent per capita income, we know A remains the most important factor in accounting for cross-country income variation.
- The 90th/10th percentile accounting in recent years gives

$$\begin{aligned} \frac{y^{90}}{y^{10}} &= \left(\frac{A^{90}}{A^{10}}\right)\left(\frac{h^{90}}{h^{10}}\right)^{1-\alpha}\left(\frac{k^{90}}{k_{10}}\right)^{\alpha}\left(\frac{l^{90}}{l^{10}}\right)^{1-\alpha} \\ 24 &= 4\cdot 3\cdot 2\cdot 1 \end{aligned}$$

Main Issue: Extremely Low Agricultural Productivity

- Poor economies exhibit a large labor productivity gap between urban and agricultural sectors (e.g. nearly factor of 5 in India).
- Caselli (2005) shows the 90th/10th percentile income difference (24) is reduced to less than 2 in the counterfactual that assumes the US level of agricultural productivity.

Why is Agricultural Productivity Low? More Facts

- Low agricultural productivity appears to stem from the persistence of small non-mechanized farms.
- Less than 10% of farms are below 10 acres in the United States and Canada, while for the three most populous low-income countries - China, India, and Indonesia - at least 80% of farms are below 10 acres (Foster and Rosenzweig, 2011).
- The urban-rural wage gaps are also large in poor economies (Young 2014, Lagakos et al 2017, Hnatkovska and Lahiri 2016). The relatively cheap labor likely helps the persistence of small-scale labor-intensive farming.

What We Do

- We quantitatively examine the effect of available insurance arrangements (urban vs rural) on agricultural productivity.

Our Mechanism

- Rural areas provide access to informal insurance arrangements – a network of friends/family that effectively insures against income fluctuations.
  - This premise has a solid foundation in the large body of literature and survey data (e.g. Townsend 1994, Udry 1994).
- Cities provide no formal or informal insurance.
  - As a result, households are less willing to migrate to cities.
  - Labor remains abundant and cheap in agriculture.
  - The incentives for switching to large-scale capital-intensive methods of farming stay weak.

Our Framework

- A dynamic GE framework
- Location Choice
- Urban Area
  - Households face uninsured labor income risk
  - Capital and urban goods are produced with CRS technology
- Rural Area
  - Households have access to complete insurance
  - Agricultural goods are produced with a general technology that allows us to endogenize labor productivity through the choice of farm size and capital intensity.
  - Capital can substitute for labor, but land is a complementary input to both.

Counterfactual

- Calibrate the model (in stationary equilibrium) to data for India around 2000
- Counterfactual:
  - An abstract policy intervention – complete insurance in the city

Main Results

- The model replicates the urban-rural productivity and wage gaps (5 and 3)
- The effects of policy intervention are large:
  - Fraction residing in city rises from 40% to 50%
  - Productivity gap is reduced by 64%
  - Wage gap is reduced by 63%
  - Agricultural Productivity rises by the factor of 2.7
    - Farm size (acres) rises by 18%
    - Capital input per farm rises by a factor of 12
- Our results suggest that social insurance policy in the city may have far reaching effects

Model

- Time is discrete and indexed by $t = 0, 1, 2...$
- N new households are born every period
- Households live for exactly 2 periods (young and old)
- There are two spatially separated locations: rural and urban.
- Newborns choose location
- Location determines sector of empl & access to insurance

Urban Location, Firms

- Urban firms produce non-agricultural good (numeraire)
- $Y_{n,t} = A_n K_{n,t}^{\alpha} N_{n,t}^{1-\alpha}$
- Given $w_{n,t}$ & r_t, the aggregate firm hires inputs to maximize profit:

$$\max_{K_{n,t}, N_{n,t}} \left\{ Y_{n,t} - w_{n,t} N_{n,t} - r_t K_{n,t} \right\}.$$

Urban Location, Households

- Face idiosyncratic labor market risk
- Risk is modelled as a stochastic endowment of effective labor units

$$\begin{aligned} \max EU_n &= E_{\zeta^y} u_{n,t}(\cdot) + \beta E_{\zeta^o|\zeta^y} u_{n,t+1}(\cdot) \\ p_{a,t} a^y_{n,t}(\zeta^y) + c^y_{n,t}(\zeta^y) + k^n_{t+1}(\zeta^y) &= w_{n,t}\kappa \exp(\zeta^y), \ \forall t, \zeta^y \\ p_{a,t+1} a^o_{n,t+1}(\zeta^y, \zeta^o) + c^o_{n,t+1}(\zeta^y, \zeta^o) &= w_{n,t+1}\kappa\gamma \exp(\zeta^o) + \\ & +r_{t+1} k^n_{t+1}(\zeta^y), \ \forall t, (\zeta^y, \zeta^o) \end{aligned}$$

- Period utility depends on individual state

$$u_{n,t} = \phi \frac{(a^y_{n,t}(\cdot) - \bar{a})^{1-\sigma}}{1-\sigma} + (1-\phi)\frac{c^y_{n,t}(\cdot)^{1-\sigma}}{1-\sigma}$$

Rural Location, Farms

- It takes 1 unit of effective labor to manage a farm
- Measure ε_t of households manage farms
- Remaining households work for wages
- Given $(r_t, q_t, w_{a,t})$, each manager solves

$$\max_{k_{a,t}, n_{a,t}\ l_{a,t}} d_t = p_{a,t} y_{a,t} - w_{a,t} n^f_{a,t} - r_t k^f_{a,t} - q_t l^f_t,$$

where

$$y_{a,t} = A_a \left[(1-\theta) \left(l^f_t \right)^{\rho} + \theta \left(\nu \left(k^f_{a,t} \right)^{\mu} + (1-\nu) \left(n^f_{a,t} \right)^{\mu} \right)^{\frac{\rho}{\mu}} \right]^{\frac{\eta}{\rho}}.$$

Rural Location, Households

- Fully insured against income fluctuations

$$\max U_a = \phi \frac{(a^y_{a,t} - \bar{a})^{1-\sigma}}{1-\sigma} + (1-\phi) \frac{\left(c^y_{a,t}\right)^{1-\sigma}}{1-\sigma}$$
$$+ \beta \left\{ \phi \frac{(a^o_{a,t+1} - \bar{a})^{1-\sigma}}{1-\sigma} + (1-\phi) \frac{\left(c^o_{a,t+1}\right)^{1-\sigma}}{1-\sigma} \right\} \text{ s.t.}$$
$$p_{a,t} a^y_{a,t} + c^y_{a,t} + p_{l,t} l_{t+1} + k_{a,t+1} = w_{a,t}$$
$$p_{a,t+1} a^o_{a,t+1} + c^o_{a,t+1} = w_{a,t+1} + r_{a,t+1} k_{a,t+1} + q_{t+1} l_{t+1} + p_{l,t+1} l_{t+1}$$

A **stationary equilibrium** is defined as allocations for the urban/rural hhs $\{a_n^y(\zeta^y),\ c_n^y(\zeta^y)\},\ k_n(\zeta^y)\}_{\zeta^y},\ \{a_n^o(\zeta^y,\zeta^o),\ c_n^o(\zeta^y,\zeta^o)\}_{(\zeta^y,\zeta^o)},\ \{a_a^y,\ c_a^y,\ k_a,\ l,\ a_a^o, a_a^o\}$, allocations for the urban firm $\{Y_n, K_n, N_n\}$ and rural farms $\{y_a, k_a^f,\ n_a^f,\ l^f, d_t\}$, prices $\{w_n,\ w_a,\ r,\ q,\ p_l\ ,\ p_a\}$, measures χ and ε such that

1. Given eq prices, allocations for the urban/rural households maximize utility s.t. BCs
2. Given eq prices, allocations for the urban firm / rural farms maximize profits
3. Market clearing conditions hold
4. No arbitrage conditions hold

No Arbitrage Conditions

- Measure χ_t of each cohort lives in the city ($N_n^y = N_n^o = \chi N$, $N_a^y = N_a^o = (1 - \chi) N$):
$$EU_n = U_a.$$
- No farms
$$d = w$$

Market Clearing

- Labor markets in rural & urban areas:

$$\begin{aligned} \varepsilon\left(N_a^y + \gamma N_a^o\right) n_a^f &= (1-\varepsilon)\left(N_a^y + \gamma N_a^o\right) \\ N_n &= N_n^y + \gamma N_n^o \end{aligned}$$

- Capital market:

$$K_n + \varepsilon\left(N_a^y + \gamma N_a^o\right) k_a^f = N_n^o k_n + N_a^o k_a$$

- Land market in agriculture:

$$\varepsilon\left(N_a^y + \gamma N_a^o\right) l^f = N_a^o l = L$$

- Goods markets:

$$\begin{aligned} \varepsilon\left(N_a^y + \gamma N_a^o\right) y_a &= N_n^y a_n^y + N_n^o a_n^o + N_a^y a_a^y + N_a^o a_a^o \\ Y_n &= N_n^y c_n^y + N_n^o c_n^o + N_n^y k_n + N_a^y c_a^y + N_a^o c_a^o + N_a^y k_a \end{aligned}$$

Calibration

- Calibrate to data for India around 2000-2015
  Labor market risk in cities – use Tauchen's method to approximate a continuous wage process (for urban male workers) with a finite state Markov chain
  - match persistence and st. dev.
  - Indian Human Development Survey (IHDS), panel wage data
  - important to get this independent measure of risk
- γ set to match the wage profile (y vs o)

Calibration

- Preferences
  - Utility weight $\phi = 0.4$ and $\bar{a} = 0.05$ set to match expenditure shares (0.5) (Anand and Prasad, 2010)
  - $\sigma = 2$ to match both IES=0.5 and ES between the two goods =0.5.
  - $\beta = 0.42$
- Urban Technology
  - $\alpha = 0.4$ (to match labor share, India KLEMS dataset)
- Rural Technology
  - $\rho = -2$ (to match the ES bw land and the labor-capital composite is 0.25, Salhofer (2000).
  - $\mu = 0.6$ (to match the ES bw labor and capital of 2.5 in ag, see Goldar et all (WP)
  - input weights θ, ν– to match input shares (India KLEMS)

Calibration

- Choose A_a, N, L, A_n, η to simultaneously match the remaining targets
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	Model	Data	Source
Labor Share in Ag	0.6	0.59	IPUMS 99
VA of ag	0.25	0.23	Census of Agriculture
Urban-Rural Wage Gap	2.7	2.95	IPUMS 99
No farms per person	0.2	0.5	Census of Agriculture

Main Results

- The model replicates the urban-rural productivity and wage gaps (almost 5 & 3).
- The effects of policy intervention are large:
  - Fraction residing in city rises from 40% to 50%
  - Productivity gap is reduced by 64%
  - Wage gap is reduced by 63%
  - Agricultural Productivity rises by the factor of 2.7
    - Farm size (acres) rises by 18%
    - Capital input per farm rises by a factor of 12
    - Total capital accumulation increased by 30%
- Our results suggest that social insurance policy in the city may have far reaching effects