Input Subsidies, Social Insurance, and Agricultural Productivity

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Motivation

- Productivity differences in agriculture between the richest and poorest countries twice as large as differences in aggregate productivity
  - Restuccia, Yang and Zhou (2008), Caselli (2005)
- Low intermediate input intensity in developing countries (fertilizers, pesticides)
  - Restuccia, Yang and Zhou (2008), Donovan (2020)
- Low productivity in agriculture in developing countries: attributed to the low use of intermediates
  - Restuccia, Yang and Zhou (2008), Donovan (2020)
- Typical policy to address low input use in developing countries: Input Subsidy Programs
  - Goal of policy: Increase agricultural productivity and reduce poverty (Chirwa and Dorward 2013)
  - These programs are large: For Malawi, 3-6% of GDP and two-fifths of the population direct beneficiaries (Arndt et al 2015)

This project

Our focus: What are the agricultural productivity and welfare impacts of input subsidies?

- For now we focus on Malawi: Rich farm level data that includes subsidies received.

Outline for today:

- Brief introduction to input subsidy programs in Malawi.
- Present a dynamic general equilibrium model that:
  - Generates lower input demand in poorer countries
  - Features subsidies on intermediate inputs
- Discuss how we plan to use the model and next steps

Input Subsidy Programs - Malawi

- The program has existed since 1998; greatly expanded in 2004 (FISP).
- The subsidy program covers fertilizers and seeds, and 95% of the price.
- No strictly defined, official eligibility criteria for the subsidy, but the intention is to target resource-poor farmers.
- Kilic et al (2015) show that relatively well off households (in terms of wealth) are the largest recipients, rather than the poor or the wealthiest.

The environment

- Time is discrete.
- Two sectors in the economy: Agriculture and Non-agriculture.
- Unit mass of infinitely lived households
  - Each owns a farm and produces agricultural goods.
  - Households consume both agricultural and non-agricultural goods.
  - Time spent between working in farm and non-agriculture.
  - The HH can only save and not borrow.
- The government taxes non-agriculture income and subsidizes intermediate inputs. We assume that targeting is exogenous in our model.

Production

- Non-Agriculture Sector: Representative firm solves

$$\max_{N_{mt}} p_{mt} A N_{mt} - w_{mt} N_{mt}$$

We normalize the price of the non-agricultural good, $p_{mt} \equiv 1$. The non-agriculture sector supplies final consumption goods and intermediate inputs for agriculture (including subsidized inputs).

- Production of agricultural goods:

$$y_{at} = z_t A (x_{at} + x_{st})^{\psi} n_{at}^{\nu} \qquad \psi + \nu < 1$$

where x_a denotes purchased intermediate inputs, x_s denotes amount of subsidized inputs and z_t is an iid household-specific productivity shock with cdf $Q(z)$.

Households

- At $t-1$, households save b_t units of the agricultural good.
- A fraction δ depreciates, and the household enters time t with $(1-\delta)b_t$ units of savings.
- The time t decision is broken into two stages:
  - *Ordering*: Intermediate inputs x_{at} are chosen.
  - *Production*: The productivity shock z_t is realized, and all production and consumption happens in this stage.

Implications of the timing:

- Uninsurable consumption + agricultural production risk + intermediate choice prior to shock realization $\Rightarrow$ households lower their demand for intermediate inputs.

Recursive Problem

Household state variable is b, and the aggregate state is $\mu(b)$, the distribution of savings across all household

- At the production stage, once the choice of intermediate inputs x_a is made, and the idiosyncratic shock z is realized, the value of entering time t with $(1-\delta)b$ savings is:

$$v^p(x,b,z) = \max_{c_a,c_m,n_a,b'} \alpha \log(c_a - \bar{a}) + (1-\alpha)\log(c_m) + \beta v^o(b')$$

$$\begin{aligned} p_a c_a + c_m + p_a b' = {} & p_{at} A z_t (x_{at} + x_{st})^{\psi} n_{at}^{\nu} - x_{at} - (1-\tau_s)x_{st} \\ & + (1-\tau_n) w_n (1-n_a) + p_a (1-\delta) b \\ & c_a \geq \bar{a}, c_n \geq 0, b' \geq 0 \end{aligned}$$

- The ordering stage value of entering time t with b savings is:

$$v^o(b) = \max_{x_a \geq 0} \int_z v^p(x_a, b, z) dQ(z)$$

Stationary Equilibrium

The stationary equilibrium of this economy is defined by an invariant distribution $\mu = \mu^*$, a value function v^o, decision rules $x_a(b)$, $n_a(b,z)$, $c_m(b,z)$, $c_a(b,z)$, $b'(b,z)$, labor choice N_m, prices p_a and w_n, and government taxes and subsidies τ_n and τ_s s.t.:

1. v^o solves the HH's problem
2. N_m solves the non-agricultural firm problem
3. The law of motion for μ, $\Lambda(\mu)$ implies $\Lambda(\mu^*) = \mu^*$ and μ^* is consistent with the decision rules and $Q(z)$
4. Markets Clear

The government budget balances in each period.

Market Clearing

- Labor Market:

$$N_m = 1 - \int_b \int_z n_a(b,z) dQ(z) d\mu$$

- Agricultural goods market:

$$\int_b \int_z c_a(b,z) dQ(z) d\mu + \int_b \int_z b'(b,z) dQ(z) d\mu = \int_b \int_z y_a(b,z) dQ(z) d\mu + (1-\delta) \int_b b d\mu$$

- Non-agricultural goods market: Let i be the index for each household

$$\int_b \int_z c_m(b,z) dQ(z) d\mu + \int_b x_a(b) d\mu + \int_{i \in [0,1]} x_s(i) di = AN_m$$

- The government budget is satisfied:

$$\tau_s \int_{i \in [0,1]} x_s(i) di = \tau_n w_n \left(1 - \int_b \int_z n_a(b,z) dQ(z) d\mu \right)$$

Next Steps and Counterfactuals

- Calibrate the model to the Malawi Integrated Household Survey data.
- Evaluate targeting implementation in the data.
  - Contrast impact of subsidy vs no subsidy
  - Contrast data targeting to alternative targeting
- Input subsidies provide farmers with modern inputs that increase productivity by reducing the volatility of yields. We plan to model this.