# Quantitative International Economics

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Weeks 7 and 8 - Economic Development - Part 2
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# Outline

- Economic Development - An introduction
- We will cover a series of tools and applications to think about economic development
  - Non-homothetic preferences
  - Structural change
  - **Heterogeneous workers and land**

# Outline

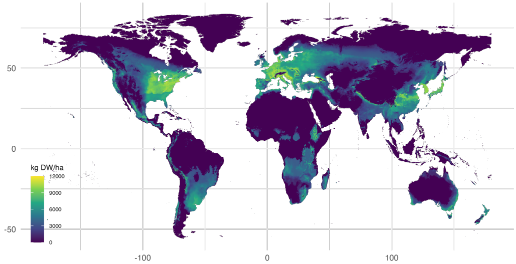
- Focus on land heterogeneity
  - Technique is very similar when applied to worker heterogeneity
- Recent evolution of land use models and data from FAO-GAEZ
- A simple land use model
- Farrokhi and Pellegrina (2023)

# Land Use Models

# Land Use Models

- Class of models that allow for rich granular geography in agricultural production and connection to rich agroclimatic (e.g., FAO-GAEZ)
  - Costinot, Donaldson, and Smith "Evolving comparative advantage and the impact of climate change in agricultural markets: Evidence from 1.7 million fields around the world" (2016)
    - Only variable input is land
  - Sotelo "Domestic trade frictions and agriculture" (2020)
    - Added variable labor and intermediate inputs
  - Farrokhi and Pellegrina "Trade, Technology and Agricultural Productivity" (2023)
    - Added multiple technology choices

# FAO-GAEZ




- GAEZ $\Rightarrow$ Global Agro-Ecological Zones
- What would be the total output of an agro-ecological zone (grid of ~10 $km^2$) if the entire area were allocated to wheat production?
  - Data comes under different assumptions on technology use (no intermediate inputs vs high intermediate inputs)
  - Important: data is constructed without any information about local market conditions

# FAO-GAEZ and TFP Calibration

- For non-agriculture sectors, we were saturating the data in terms of the gross output
  - Based on assumptions about production function, and implied use of factors of production, we could invert the model to recover the TFP
- For agriculture, we will be able to use FAO-GAEZ as our measures of TFP
  - Unique to agriculture, agroclimatic characteristics contain very useful information about productivity
  - No saturation of the data

# Applications using FAO-GAEZ

- Other structural applications
  - Conte (2024), Dominguez-Iino (2024), Pellegrina (2022), Adamopoulos and Restuccia (2022)
- RF applications
  - Bustos, Caprettini and Ponticelli (2016) Bustos, Garber and Ponticelli (2020), Nunn and Qian (2011), Fiszbein (2022)

# A Simple Agricultural Economy

- Many countries indexed by $i, n \in \mathcal{I}$
  - Every country endowed with land $L_i$
- Many crops indexed by $k \in \mathcal{K}$
- Iceberg trade costs $\tau_{in}$

# Preferences

- Upper-tier: choice of crops

$$C_i = \left( \sum_k a_{ik}^{\frac{1}{\kappa}} C_{ik}^{\frac{\kappa-1}{\kappa}} \right)^{\frac{\kappa}{\kappa-1}}$$

- Lower-tier: choice of origin

$$C_{i,k} = \left( \sum_{n \in \mathcal{I}} a_{ni,k}^{\frac{1}{\kappa}} C_{ni,k}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

# Consumption Choices

- Share of consumption in crop $k$

$$\beta_{i,k} = \frac{a_{i,k} P_{i,k}^{1-\kappa}}{P_i^{1-\kappa}}$$

where

$$P_i^{1-\kappa} = \sum_{k \in \mathcal{K}} a_{i,k} P_{i,k}^{1-\kappa}$$

- Share of consumption in goods from origin $i$

$$\beta_{in,k} = \frac{a_{in,k} \left(p_{i,k} \tau_{in,k}\right)^{1-\sigma}}{P_{i,k}^{1-\sigma}}$$

where

$$P_{i,k}^{1-\sigma} = \sum_{n \in \mathcal{I}} a_{ni} \left(p_{n,k} \tau_{ni,k}\right)^{1-\sigma}$$

# Production

- Every country is split into many fields $f \in \mathcal{F}_i$ of equal sizes. Every field constitutes of a continuum of plots $\ell$
  - Field will correspond to grids in the data from FAO-GAEZ
- Technology in plot $\ell$, field $f$ in country $i$ of crop $k$ is

$$Q_{i,k}^{f}(\ell) = z_{i,k}^{f}(\ell)\, L_{i,k}^{f}(\ell)$$

  - $L_{i,k}^{f}(\ell)$ is the amount of land that agricultural producer allocates to crop $k$ in plot $\ell$
- Revenues from allocating plot $\ell$ to crop $k$ is

$$Y_{i,k}^{f}(\ell) = p_{i,k} Q_{i,k}^{f}(\ell) = p_{i,k} z_{i,k}^{f}(\ell)\, L_{i,k}^{f}(\ell)$$

- Within a <u>plot</u>, all land will be allocated to the production of a single crop

# Land use choices

- Agricultural producers choose to produce the crop that maximizes their revenues in every plot

$$\max_k \left\{ p_{i,1} z^f_{i,1}(\ell), \ldots, p_{i,K} z^f_{i,K}(\ell) \right\}$$

- Assume that $z^f_{i,k}(\ell)$ is drawn from a Fréchet with location parameter $T^f_{i,k}$ and dispersion parameter $\theta$

- Integrate discrete choices that maximum land revenues over continuum of plots to obtain

$$\alpha^f_{i,k} = \frac{\left( T^f_{i,k} p_{i,k} \right)^\theta}{\sum_{k'} \left( T^f_{i,k'} p_{i,k'} \right)^\theta}$$

# Quantities produced

- Quantity of crop $k$ produced in field $f$

$$Q^f_{i,k} = T^f_{i,k} \left(\alpha^f_{i,k}\right)^{\frac{\theta-1}{\theta}}$$

- Quantity of crop $k$ produced in country $i$

$$Q^f_{i,k} = \sum_{f \in \mathcal{F}_i} Q^f_{i,k}$$

# General Equilibrium

- Income

$$E_i = \sum_{k \in \mathcal{K}} p_{i,k} Q_{i,k} \tag{1}$$

- Trade

$$X_{in} = \beta_{in,k} \beta_{n,k} E_n \tag{2}$$

where

$$\beta_{in,k} = \frac{a_{in,k} \left(p_{i,k} \tau_{in,k}\right)^{1-\sigma}}{P_{i,k}^{1-\sigma}} \quad \text{and} \quad \beta_{i,k} = \frac{a_{i,k} P_{i,k}^{1-\kappa}}{P_i^{1-\kappa}} \tag{3}$$

$$P_{i,k}^{1-\sigma} = \sum_{n \in \mathcal{I}} a_{ni} \left(p_{n,k} \tau_{ni,k}\right)^{1-\sigma} \quad \text{and} \quad P_i^{1-\kappa} = \sum_{k \in \mathcal{K}} a_{i,k} P_{i,k}^{1-\kappa} \tag{4}$$

- Production

$$Q_{n,k} = \sum_{f \in \mathcal{F}_i} T_{i,k}^f \left(\alpha_{i,k}^f\right)^{\frac{\theta-1}{\theta}} \quad \text{and} \quad \alpha_{i,k}^f = \frac{\left(T_{i,k}^f p_{i,k}\right)^{\theta}}{\sum_{k' \in \mathcal{K}} \left(T_{i,k'}^f p_{i,k'}\right)^{\theta}} \tag{5}$$

**Definition**: Given technology $\{T_{n,k}^f\}_{f,k}$ and $\{\theta\}$, trade costs $\{\tau_{ni}\}_{ni}$, and preferences $\{\sigma, \kappa, a_{in,k}, a_{i,k}\}$, an equilibrium is a vector of prices $\{p_{i,k}\}_{i,k}$ that satisfies equations (1)-(5).

# An Algorithm

- Step 1: Guess a vector of wages $p^g_{i,k}$ (pick a normalization)
- Step 2: Construct $E_n$
- Step 3: Construct $\beta_{ni,k}$, $\beta_{i,k}$ and $X_{in,k}$
- Step 4: Construct the demand for crop $Q^{dem}_{i,k} = \sum_k \sum_i X_{in,k}/p^g_{i,k}$
- Step 5: Construct the supply for crop $Q^{sup}_{i,k} = \sum_{f \in \mathcal{F}_i} T^f_{i,k} \left(\alpha^f_{i,k}\right)^{\frac{\theta-1}{\theta}}$
- Step 6: Check goods market clearing
  - If $\max_i\{|Q^{dem}_{i,k} - Q^{sup}_{i,k}|\} < \epsilon$ and $\max_i\{|Q^{dem}_{i,k} - Q^{sup}_{i,k}|\} < \epsilon$ , then stop algorithm
  - Otherwise, update $p^g_{i,k}$ go back to step 2
    - Increase $p^g_{i,k}$ if $Q^{dem}_{i,k} - Q^{sup}_{i,k} > 0$ and decrease $p^g_{i,k}$ if $Q^{dem}_{i,k} - Q^{sup}_{i,k} < 0$

# Calibration of $T^f_{i,k}$

- What is the total output of a field $f$ if the entire area was allocated to crop $k$?

$$\begin{aligned} q^f_{i,k} &= T^f_{i,k} \left( \underbrace{\alpha^f_{i,k}}_{=1} \right)^{\frac{\theta-1}{\theta}} \\ &= T^f_{i,k} \end{aligned}$$

- FAO-GAEZ $\Rightarrow$ total output if the entire field were allocated to crop $k$, call it $T^{f,GAEZ}_{i,k}$

- We can then set

$$T^f_{i,k} = T^{f,GAEZ}_{i,k}$$

- And simulate the model using these value for $T^f_{i,k}$

# Returns to land

- In Eaton and Kortum (2002), the avg. price of goods coming from any importing country was the same. What is the equivalent result here?
- The avg. return to land allocated to each crop $k$ will be the same within a field, in other words

$$E\left(y_{i,k}^{f}(\ell)\right)=E\left(y_{i,k}^{f}(\ell)\,|k\right)\ \text{ for any } k$$

- To see this, write the measured yield (output per hectare) of a crop in field $f$, $y_{i,k}^{f}$,

$$y_{i,k}^{f}=\frac{p_{i,k}T_{i,k}^{f}\left(\alpha_{i,k}^{f}\right)^{\frac{\theta-1}{\theta}}}{\alpha_{i,k}^{f}}\Rightarrow y_{i,k}^{f}=\left(\sum_{k'}\left(T_{i,k'}^{f}p_{i,k'}\right)^{\theta}\right)^{\frac{1}{\theta}}$$

- If I increase the productivity of a single crop $k'$, $T_{i,k'}^{f}$, then the measured yield of all crops will experience the same increase
  - When you use these techniques to model worker heterogeneity in productivity, you will get the same implication: avg. returns to labor (or avg wage) across choices are equalized

# Farrokhi and Pellegrina (2023)

# Introduction

- Technology adoption often depends on having access to foreign intermediate inputs
  - E.g. semiconductors for eletronics, garment machinery for textile
- Technology adoption in agriculture has been crucial for economic development
  - Agricultural modernization: Traditional (labor-intensive) $\rightarrow$ Modern (input-intensive)
    - Johnston and Mellor (1961), Schultz et al. (1968), Gollin et al. (2007)
  - Little is known about the role of int'l trade
  - 2/3 of intermediate inputs in agriculture are purchased in int'l markets
- **This paper**: What is the impact of int'l trade on agricultural technology adoption? What are the implications for ag productivity and welfare across the world?

# Introduction: Traditional vs Modern Agriculture

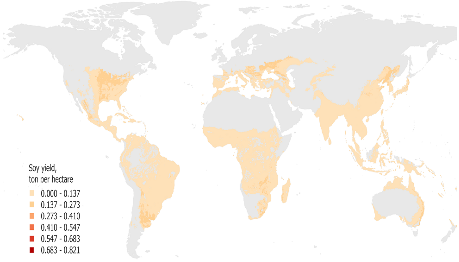
Traditional (labor-intensive)

Modern (input-intensive)

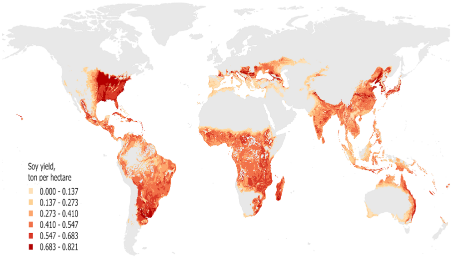
# Measures of Productivity by Crop and Technology

- **FAO-GAEZ**: Potential yields for every crop-technology pair in more than one million fields (grid-cells) based on agroclimatic conditions

a. Traditional Technology




b. Modern Technology



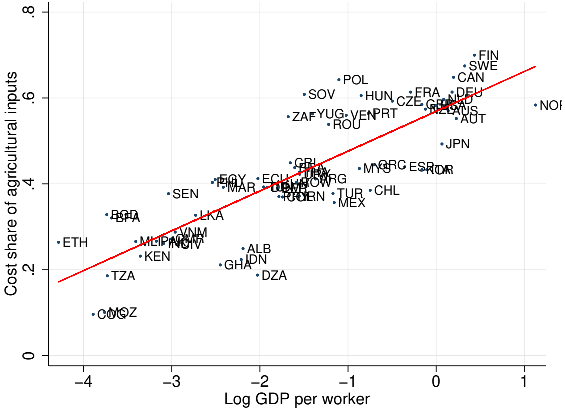
# What we do

- Empirical patterns: economic development, agr-input use, and trade
- Global trade model: rich spatial structure + endogenous technology choice
  - In every field: choices of what crop to produce and with which technology
  - We bridge two approaches
    - Crop specialization and comp. adv. (Costinot et al. 2016, Sotelo 2020) $\rightarrow$ *Not technology choice*
    - Agricultural modernization in closed-economy (Gollin et al., 2017) $\rightarrow$ *No trade*
    - **This paper:** trade in ag inputs $\rightarrow$ choices of technology $\rightarrow$ ag productivity
  - Analytical results for the GFT and PPF
- Estimate the model to evaluate
  - Effects of globalization in agriculture $\rightarrow$ $\Delta$ trade costs 1980-2007
  - Global transmission of shocks $\rightarrow$ $\Delta$ productivity of ag-input sector 1980-2007

# Data

- **Cross-country**: 65 countries + ROW
  - Production and trade by sector (UN, FAOSTAT, and others)
  - Agricultural input use
  - Crop production (FAOSTAT)
- **Field-level**: approximately 1.1 mi fields (5 minutes arc $\sim 10 \times 10 \ km$)
  - Potential yields by crop and technology
  - FAO-GAEZ
- **Microregion**: 80 thousand microregions
  - Input use (fertilizers, pesticides, machinery, etc) at the plot, farm or microregion level
  - Source: LSMS (World Bank) + agricultural censuses
  - 10 Countries: COL, IND, UGA, GHA, ETH, NGA, ARG, BRA, PER, MWI

# Empirical Pattern 1: GDP per capita and cost share of ag inputs



R2 = 0.68 and slope = 0.09

# Empirical Patterns 2 and 3

- **Empirical pattern 2**: Import content of agricultural input use is large
  - On avg, imports account for **65% of a country's expenditure on agricultural inputs**
  - Several countries import more than **90% of their agricultural inputs**
  - Production is **globally concentrated**
    - Fertilizers $\rightarrow$ availability of natural resources
    - Tractors and pesticide $\rightarrow$ production capability in machinery and chemicals

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- **Empirical pattern 3**: large potential yield improvement from modern over traditional technology (FAO-GAEZ)
  - No corr. between yield improvements and GDP per capita

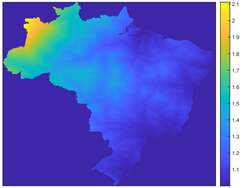
# Empirical Pattern 4: Modern Technology and Internal Geography

- Corr. between access to exporting hubs and technology adoption

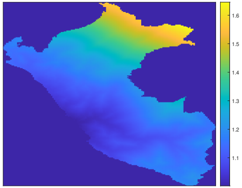
$$(\text{modern share})_{\ell i,k} = \delta_{i,k} + \beta \log\left(\text{Trade Cost to nearest Hub}\right)_{\ell i} + \epsilon_{\ell i,k}$$

  - modern share$_{\ell i,k}$: is the share of area in microregion $\ell$ producing crop $k$ using modern technologies (any chemical fertilizer) in country $i$
  - Trade cost to hubs based on Allen and Arkolakis (2014) using data on
    - Exporting hubs (main ports and big cities)
    - Rivers, roads and railroads

Brazil




Peru



# Empirical Pattern 4: Modern Technology and Internal Geography

| | DV: Modern Land Share | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| log(Trade Cost to Nearest Hub) | -0.536*** | -0.608*** | -1.312*** |
| | (0.146) | (0.156) | (0.180) |
| R2 | 0.114 | 0.309 | 0.441 |
| Obs | 78250 | 78199 | 78199 |
| Country FE | Y | | |
| Country-crop FE | | Y | Y |
| Potential Yield | | | Y |

# The Model

- Multiple countries $i \in \mathcal{N}$
  - Endowed by Land ($L_n$), Labor ($N_n$), Raw Fertilizers ($V_n$)
- Space of goods, $g = \underbrace{0}_{\text{non-ag}}, \underbrace{1, ..., J}_{\text{ag-inputs} j \in \mathcal{J}}, \underbrace{J+1, ..., J+K}_{\text{ag-output} k \in \mathcal{K}}$
  - A non-agricultural good, multiple ag-inputs $j \in \mathcal{J}$, multiple ag-outputs $k \in \mathcal{K}$
- Consumption: three tier (Armington) structure
  - Upper tier: CES for ag vs non-ag
  - Middle tier: CES between agricultural goods (e.g., wheat vs soy)
  - Lower tier: CES between varieties from different countries (e.g., soy from Brazil vs from USA)
- Iceberg international trade costs $d_{ij,g}$

# The Model: Field-level ingredients

- Land $L_n$ consists of many fields $f$, each consisting of a continuum of plots $\omega$
  - In each plot $\omega$, ag producers choose a crop-technology pair
- Production function

$$Q^f_{i,k\tau}(\omega) = \bar{q}_{k\tau}\Big( \underbrace{z^f_{i,k\tau}(\omega)}_{\text{productivity}} \; \underbrace{L^f_{i,k\tau}(\omega)}_{\text{land}} \Big)^{\gamma^L_{k\tau}} \Big( \underbrace{N^f_{i,k\tau}(\omega)}_{\text{labor}} \Big)^{\gamma^N_{k\tau}} \underbrace{\left( \prod_{j \in \mathcal{J}} \left( M^{j,f}_{i,k\tau}(\omega) \right)^{\lambda^j_k} \right)^{\gamma^M_{k\tau}}}_{\text{ag inputs}}$$

- Technologies: Traditional ($\tau = 0$), Modern ($\tau = 1$)
  - $\gamma^M_{k0} = 0$ for traditional technology
  - $\gamma^M_{k1} > 0$ for modern technology

# Agricultural production at the plot level

- Returns to land in plot $\omega$:

$$r^f_{i,k\tau}(\omega) = \underbrace{z^f_{i,k\tau}(\omega)}_{\text{land productivity}} \times \underbrace{h_{i,k\tau}}_{\text{price effect}}$$

- Price effect:

$$h_{i,k\tau} = \underbrace{p_{i,k}}_{\text{output price}} \times \underbrace{\left(\frac{w_i}{p_{i,k}}\right)^{-\gamma^N_{k\tau}/\gamma^L_{k\tau}} \left(\frac{m_{i,k}}{p_{i,k}}\right)^{-\gamma^M_{k\tau}/\gamma^L_{k\tau}}}_{\text{relative wage \& input price}}$$

- In every plot $\omega$, choose crop-technology pair with highest return: $\max_{k\tau}\{r^f_{i,k\tau}(\omega)\}$
- Aggregate supply:
  - Sum over plot-level choices $\rightarrow$ Field-level quantities
  - Sum over field-level quantities $\rightarrow$ Country-level quantity

# The Model: Aggregation over plot-level choices

- Vector of productivities, $\mathbf{z}_i^f(\omega)$, drawn from a generalized Frechet See details
  - $a_{i,k\tau}^f \rightarrow$ controls **average** productivity draws across plots
  - $\theta_1$ and $\theta_2 \rightarrow$ control the **dispersion** of draws between “crops” and between “technologies”
- Fraction of land in field $f$ allocated to crop-technology $(k, z)$

$$\pi_{i,k\tau}^f = \underbrace{\frac{(H_{i,k}^f)^{\theta_1}}{\sum_{k\in\mathcal{K}}(H_{i,k}^f)^{\theta_1}}}_{\substack{\alpha_{i,k}^f \\ \text{share of land in crop } k}} \times \underbrace{\frac{\left(a_{i,k\tau}^f h_{i,k\tau}\right)^{\theta_2}}{(H_{i,k}^f)^{\theta_2}}}_{\substack{\alpha_{i,k\tau}^f \\ \text{share of land in tech } \tau \text{ within crop } k}}$$

  - $h_{i,k\tau}$: return to crop-technology pair
  - $H_{i,k}^f = \left(\sum_\tau (a_{i,k\tau}^f h_{i,k\tau})^{\theta_2}\right)^{1/\theta_2}$: avg return to crop $k$

# The Model: Aggregation over field-level quantities

- Output quantities at the field-level

$$Q^f_{i,k\tau} \propto L^f_i \times \underbrace{a^f_{i,k\tau}}_{\text{productivity}} \times \underbrace{(\alpha^f_{i,k})^{\frac{\theta_1-1}{\theta_1}}}_{\text{crop choice}} \times \underbrace{(\alpha^f_{i,k\tau})^{\frac{\theta_2-1}{\theta_2}}}_{\text{technology choice}}$$

  - $\alpha^f_{i,k}$: Share of area in crop $k$
  - $\alpha^f_{i,k\tau}$: Share of area in technology $\tau$ (given crop $k$)

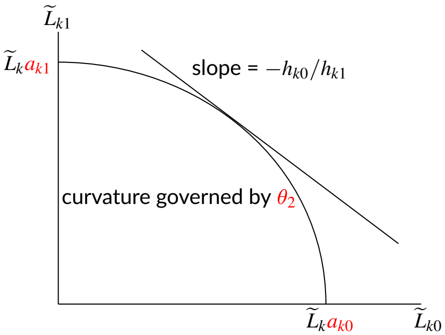
- Output quantities for a given crop at the country-level

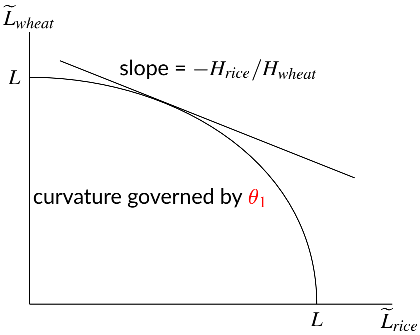
$$Q_{i,k} = \sum_{f \in \mathcal{F}_i} \sum_{\tau} Q^f_{i,k\tau}$$

- General equilibrium: Prices that equalize demand and supply of all goods in all locations

# Analytical Discussion: Production Possibility Frontier (PPF)

- **PPF in every field (within a country):** representation with 2 crops and 2 technologies




- Each country is a *collection* of PPFs

# Analytical Discussion: Gains from Trade

- Pared-down version of the model
  - One agricultural good + One big plot $f$ per country
  - No domestic production of ag inputs $\rightarrow$ only traditional technology in autarky
- The gains from trade:

$$G_i = 1 - \underbrace{(\lambda_{ii})^{\frac{1}{\sigma-1}}}_{\textit{Trade}} \underbrace{(\alpha_{i,0})^{\frac{1}{\theta_2}}}_{\textit{Technology}}$$

  - $\lambda_{ii}$: domestic share of expenditure
  - $\alpha_{i,0}$: share of land allocated to traditional technology
  - Back of the envelope calculations
    - For COL, $\lambda_{ii} = 0.85$ and $\alpha_0 = 0.55$, evaluated at $\sigma = 5.7$ and $\theta_2 = 4.5$
    - GFT with ACR only $3.4\%$ $\rightarrow$ GFT with Technology $18.6\%$
- (In the paper) General version for welfare changes Check expressions

# Taking the Model to Data

- Full-fledge, quantative model brings in two additional features

1. **Internal geography**: hub-and-spoke
    - Agricultural producers can only sell ag-output and buy ag-input via the hub (ports and major cities)
    - Trade costs to the hub depend on internal geography (railroads, highways and rivers) as in Allen and Arkolakis (2014)
2. **Worker heterogeneity:** Lagakos and Waugh (2013)
    - Labor market frictions
    - Workers have heterogeneous skills

# Taking the Model to Data

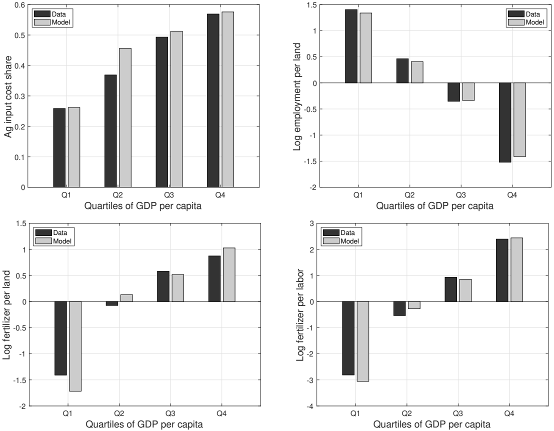
- **Data**: 65 countries and ROW in 2007 + 10 crops + 3 ag-inputs
- **First step**: estimation of demand side parameters
  - Demand shifters and elasticity estimated from gravity equations
- **Second step**: estimation of supply side parameters
  - Minimize distance between data-moments and their model counterparts
    - Moments based on within country variations in land use
    - Identify $\theta_1$ and $\theta_2$
  - Calibration of productivity shifters $a^f_{i,k\tau}$
    - Relative $a^f_{i,k\tau}$ comes from FAO-GAEZ
  - Calibration is embedded *within* the estimation algorithm (solves the entire GE)

# Taking the Model to Data

| Parameter | Description | Source | Estimate |
|---|---|---|---|
| a. Demand-side $(\Omega_D)$ | | | |
| $\sigma_g$ for $g \in \mathcal{K}$ | Elasticity of subst. between countries - crops | International trade flows of crops | 5.76 (0.32) |
| $\sigma_g$ for $g \in \mathcal{O}, \mathcal{J}$ | Elasticity of subst. between countries - other goods | Literature | 4 |
| $\kappa$ | Elasticity of subst. between crops | Country-level expenditure on crops | 4.16 (0.49) |
| $\eta$ | Elasticities of subst. between agr. and nonagr. | Comin et al. (2015) | 0.5 |
| b. Supply-side $(\Omega_S)$ | | | |
| $\theta_1$ | Productivity dispersion between crops | Minimum Distance | 1.38 (0.19) |
| $\theta_2$ | Productivity dispersion between technologies | Minimum Distance | 4.51 (0.45) |
| $d^f_{i,k\tau}$ | Crop-technology productivity shifter | Potential yields from FAO-GAEZ | - |
| $d^f_{i,0}$ | Investment intensity parameter | Cropland share from EarthStat | - |
| $\gamma^N_{k\tau}, \gamma^L_{k\tau}, \gamma^M_k, \gamma^{j,M}_k$ | Factor and input shares | USDA data & Cross-country input cost share | - |
| $\psi$ | Between-sector labor supply elasticity | Literature | 2 |

- $b_{ni,g} d_{ni,g}^{1-\sigma_g}$, $b^0_n$, $b^1_n$, $A_{i,g}$, $d^{f'}_{n,g}$ $\rightarrow$ residuals and trade costs

# Model Fit




- Input intensity parameters ($\gamma_{k\tau}^{M}$) are ***exogenous*** and not country-specific
- Cross-country differences come from ***endogenous*** technology choices

# Counterfactual: Globalization in Agricultural Inputs and Outputs

- **Question**: What were the effects of globalization in agr inputs and outputs?
  - Measure reductions in int'l trade cost between 1980 and 2007 (Head and Ries, 2004)
  - **Counterfactual 1**: agricultural inputs + outputs
  - **Counterfactual 2**: agricultural inputs
  - **Counterfactual 3**: agricultural outputs
- **Interpretation**: From baseline to counterfactual $\rightarrow$ impact of no globalization

# Counterfactual: Globalization in Agricultural Inputs and Outputs

| | Changes in Trade Costs in Agriculture | | |
|---|---|---|---|
| | Output and Input | Only Input | Only Output |
| | (1) | (2) | (3) |
| *a. Domestic expenditure shares* | | | |
| Agricultural input | 18.8 | 19.8 | -1.8 |
| Agricultural output | 6.9 | -1.0 | 8.0 |
| *b. Agricultural production* | | | |
| Share of land in modern | -5.1 | -6.1 | 1.2 |
| Yield (avg across crops) | -8.5 | -7.7 | -0.4 |
| Agricultural labor share | 5.6 | 3.8 | 1.7 |
| *c. Welfare* | | | |
| Welfare from food | -6.5 | -3.4 | -3.0 |
| Welfare | $\boxed{-3.3}$ | -1.6 | -1.6 |

- *Global* welfare $\downarrow$ 3.3%

# Counterfactual: Globalization in Agricultural Inputs and Outputs

| | Changes in Trade Costs in Agriculture | | |
|---|---|---|---|
| | Output and Input | Only Input | Only Output |
| | (1) | (2) | (3) |
| *a. Domestic expenditure shares* | | | |
| Agricultural input | 18.8 | 19.8 | -1.8 |
| Agricultural output | 6.9 | -1.0 | 8.0 |
| *b. Agricultural production* | | | |
| Share of land in modern | -5.1 | -6.1 | 1.2 |
| Yield (avg across crops) | -8.5 | -7.7 | -0.4 |
| Agricultural labor share | 5.6 | 3.8 | 1.7 |
| *c. Welfare* | | | |
| Welfare from food | -6.5 | -3.4 | -3.0 |
| Welfare | -3.3 | -1.6 | -1.6 |

- Impact of globalization in inputs and output is comparable

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- Types of globalization operate via different domestic expenditure shares

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- Share of land in modern technology $\downarrow$ 6.1% (comes from trade in inputs)

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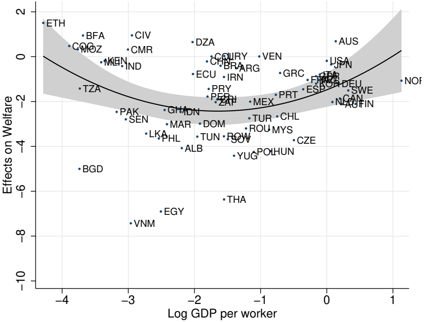
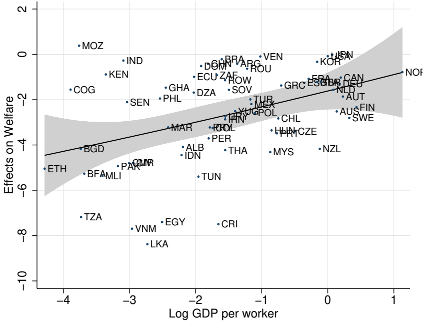
Input Only




Output Only




- Two types of globalization have substantially different distributional implications
  - $\uparrow$ trade cost in **ag-output** $\rightarrow$ harms mostly **low-income countries**
  - $\uparrow$ trade cost in **ag-input** $\rightarrow$ harms mostly **middle-income countries**

# Conclusion

- International trade is crucial for the use of modern ag-inputs
- We endogenize technology choice in an agricultural trade model
  - Estimate the model using FAO-GAEZ data
- Global trade in agricultural inputs has
  - Important implications to **global welfare** (*comparable to globalization in ag-output)*
  - But substantially *different* implications to **global welfare inequality**
- Foreign productivity shocks played a key role
  - As important for welfare as domestic productivity shocks
  - "External push force"