Trade, Technology, and Agricultural Productivity

by Farrokhi and Pellegrina (2023)

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Env Reading Group

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Introduction

- The paper studies the contribution of trade in agricultural inputs, machinery and fertilizers, to the diffusion of agricultural technology.
- Agricultural technologies require the use of certain intermediate inputs, like tractors. On average, two-thirds of every dollar spent on these agricultural inputs are paid to foreign suppliers.
- Two mechanisms for the role of trade for agricultural productivity:
  1. With trade, foreign productivity growth in the production of agricultural inputs can increase domestic agricultural productivity;
  2. Reductions in trade barriers allocate resources more efficiently through both input and output side of agricultural production.

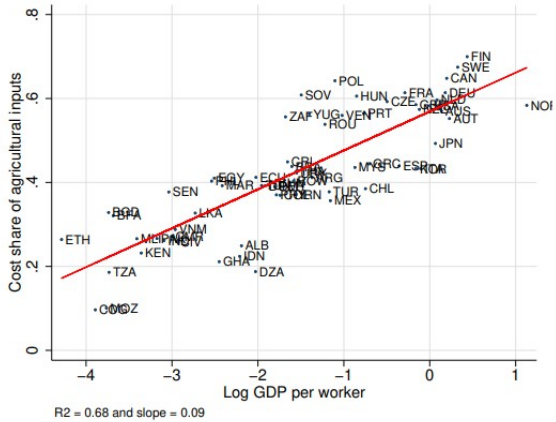
Research Question

- What were the consequences of the fall of trade barriers on agricultural productivity and welfare around the world?
  1. trade in agricultural outputs encourages crop specialization;
  2. (contribution) trade in agricultural inputs incentivizes the use of modern technologies.
- How was productivity growth in the production of agricultural inputs transmitted across borders by means of trade? foreign inputs v.s. domestic ones.

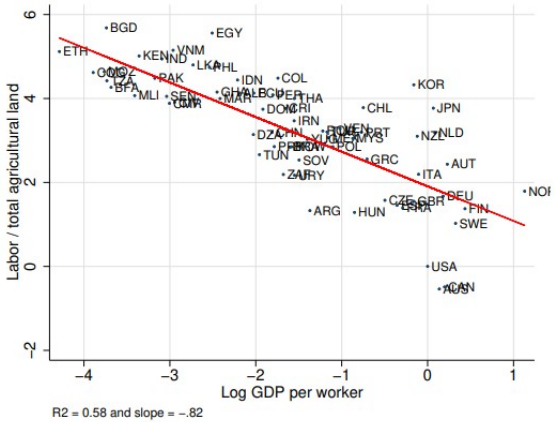
Pattern 1: More Developed, More Modern

- Countries with higher GDP per capita use inputs more intensively relative to land or labor, whereas they save on labor per unit of land.

(a) Cost share of Agricultural Inputs



(b) Labor per Land



Pattern 2: High Dependence, High Concentration

- The import share of agricultural inputs is large, and exports of agricultural inputs are concentrated in a relatively small number of countries.

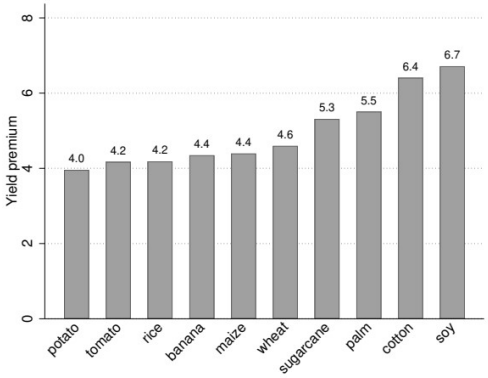
TABLE 1
IMPORT SHARE OF AGRICULTURAL INPUTS

	IMPORTS AS SHARE OF COUNTRY'S EXPENDITURE				EXPORTS AS SHARE OF GLOBAL EXPORTS	
	Average (1)	p10 (2)	p50 (3)	p90 (4)	Top 10 (5)	Not Top 10 (6)
All	.65	.31	.70	.91	.77	.23
Fertilizer	.69	.36	.74	.97	.82	.18
Machinery	.67	.28	.73	.93	.78	.22
Pesticide	.69	.30	.72	.99	.85	.15

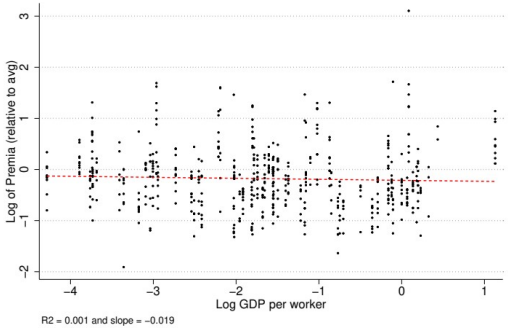
Pattern 3: Large Premium of Modern Technology

- Potential yield premia of modern technologies are, on average, large; and do not vary systematically with GDP per capita.

(a) Average across crops



(a) Unconditional



Pattern 4: Cost Increases with Domestic Distance to Trade Hub

- Relationship between proximity to trade hubs within each country and the observed use of modern technologies:

$$y_{lik} = \delta_{ik} + \beta \log x_{li} + \epsilon_{lik} \tag{1}$$

  - l: region; i: country (10 countries); k:crop.
  - y: the share of land in which modern technology is employed.
  - x: trade cost to nearest hub.

- Trade hubs: largest ports or population centers from which farmers can purchase intermediate inputs;

Pattern 4: Cost Increases with Domestic Distance to Trade Hub

TABLE 2
RELATIONSHIP BETWEEN TECHNOLOGY CHOICES AND TRADE COST TO NEAREST TRADING HUB ACROSS MICROREGIONS

	DEPENDENT VARIABLE: MODERN LAND SHARE		
	(1)	(2)	(3)
log(trade cost to nearest hub)	−.536***	−.608***	−1.312***
	(.146)	(.156)	(.180)
R^2	.114	.309	.441
Observations	78,250	78,199	78,199
Country fixed effects	Yes		
Country-crop fixed effects		Yes	Yes
Potential yield			Yes

- Agricultural producers in remote areas of a country have lower incentives to adopt modern technologies.

Stylized Model

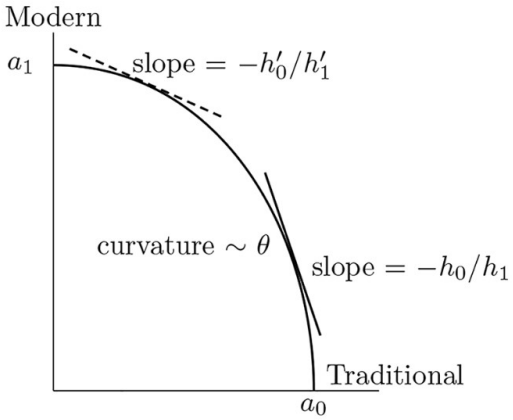
- Two countries, indexed by $i \in \{\text{Home,RoW}\}$. Each is endowed by a given amount of land, L_i, and produce a variety of agricultural goods.
- RoW produces an agricultural input good from endowments that are located only there.
- In each country, the land consists of a continuum of heterogeneous plots, ω.
- Production technology

$$\text{(traditional)} \quad Q_{i0}(\omega) = z_{i0}(\omega) L_{i0}(\omega) \tag{2}$$

$$\text{(modern)} \quad Q_{i1}(\omega) = (z_{i1}(\omega) L_{i1}(\omega))^{\gamma} M_i(\omega)^{1-\gamma} \tag{3}$$

- Productivities $(z_{i0}(\omega), z_{i1}(\omega))$ are drown independently across plots from a distribution with dispersion parameter θ and scale parameters a_{i0} and a_{i1}.

Stylized Model



Exercise 1: Effect of Globalization on Agricultural Productivity

- Compare the counterfactual economy, where trade costs of both agricultural inputs and outputs are set to their levels in 1980, with the baseline of 2007.
- Decompose the effects from input side and output side: we set only trade costs of inputs (or outputs) to their level of 1980.

Exercise 1: Effect of Globalization on Agricultural Productivity

- Result 1: less land employing modern technology, lower yield and lower welfare.
- Result 2: the effects of globalization on welfare via the input side of agriculture are as important as the output side.
- Result 3: the effects from the input side affects agricultural productivity more dramatically than the output side.

Exercise 1: Effect of Globalization on Agricultural Productivity

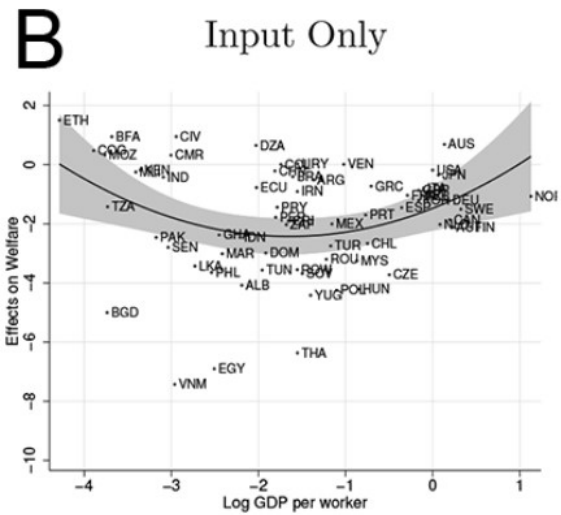
TABLE 4
IMPACT OF CHANGES IN TRADE COSTS FROM BASELINE IN 2007 TO COUNTERFACTUAL ECONOMY IN 1980 (Percentage Change)

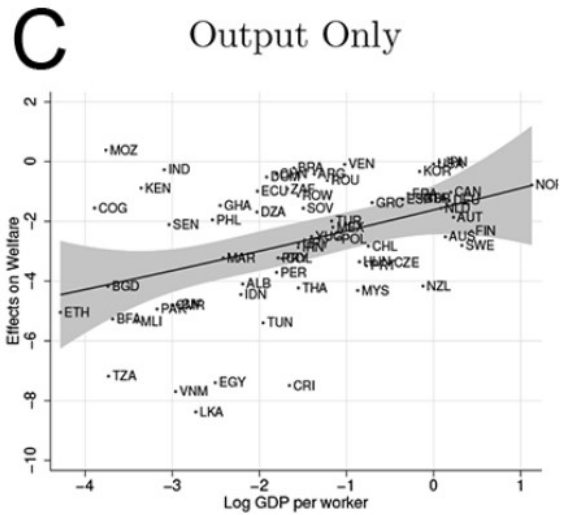
	Changes in Trade Costs in Agriculture		
	Output and Input (1)	Only Input (2)	Only Output (3)
	A. Domestic Expenditure Shares		
Agricultural input	18.8	19.8	−1.8
Agricultural output	6.9	−1.0	8.0
	B. Agricultural Production		
Share of land in modern	−5.1	−6.1	1.2
Yield (average across crops)	−8.5	−7.7	−.4
Agricultural labor share	5.6	3.8	1.7
	C. Welfare		
Generalized average:			
Welfare from food	−6.5	−3.4	−3.0
Welfare	−3.3	−1.6	−1.6
Simple average:			
Welfare from food	−10.3	−4.4	−6.0
Welfare	−4.6	−1.8	−2.7

Exercise 1: Effect of Globalization on Agricultural Productivity

- Result 4: Reduction in trade costs of inputs compared with outputs have substantially different distributional implication:
  1. Globalization in agricultural outputs benefits low-income countries because they have a larger expenditure share on food.
  2. Globalization in agricultural inputs benefits middle-income countries the most.
- Intensive margin: globalization decreases production costs in the land already using modern technology (negligible in low-income country)
- Extensive margin: globalization increases the adoption of modern technologies (negligible in high-income country since they already have a large share of land in 1980)

Exercise 1: Effect of Globalization on Agricultural Productivity





Exercise 2: Effect of Foreign Production in Inputs on Domestic Agriculture

- Goal: quantify the effect of foreign productivity growth in the agricultural input sector on domestic agricultural productivity.
- "Shocks to all countries": productivities of agricultural inputs in all countries are set to their level of 1980;
- "Shocks country by country": set productivities of agricultural inputs to the 1980 levels for each country, one at a time.
- Results: across countries, 72% of the welfare loss can be attributed to foreign productivity shocks. Welfare loss from "shocks to all countries" on average is 8.6% and welfare loss from foreign productivity shocks is 6.2%.

References

Farrokhi, F. and Pellegrina, H. S. (2023). Trade, technology, and agricultural productivity. *Journal of Political Economy*, 131(9):2509–2555.