Selection, Agriculture, and the Gains from Trade

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Y/N Differences Large in Agriculture, Small in Non-Agriculture

Cross-country labor productivity differences:

Sector	Labor Productivity Ratio of 90th-10th Percentile
Agriculture	45
Aggregate	22
Non-Agriculture	4

Data Source: Caselli (2005)

Our View: Aggregate Factors $\Rightarrow$ Sectoral Y/N Gaps

Previous literature: Non-agriculture is ok; something wrong with agriculture.

- Barriers to intermediates in agriculture; Restuccia, Yang, and Zhu (2008).
- Misallocation of resources across farms; Adamopoulos, Restuccia (2011).

Our view: The whole economy is messed up (e.g. bad institutions) leading to:

- Low efficiency of production in all sectors,
- Lower measured agriculture productivity relative to aggregate,
- Higher measured non-agriculture productivity relative to aggregate.

Lagakos and Waugh (2011)

Environment:

- Countries differ in "economy-wide efficiency" and are closed economies.
- Workers have subsistence food consumption requirements.
- Workers in each country differ in productivity in agriculture and non-agriculture; choose where to work, Roy (1951).

Mechanism: When economy-wide efficiency is *low*

- Most workers must work in agriculture
- Average agriculture worker has *low* agriculture productivity
- Average non-agriculture worker has *high* non-agriculture productivity

Trade Solves Everything . . . Maybe

Traditional view: Sectoral productivity data $\Rightarrow$ large gains from trade.

- Poor countries import food, labor moves to non-agriculture, Y/L goes up.
- Tombe (2011) quantifies this in a multi-sector extension of Eaton and Kortum (2002) and Yi and Zhang (2011).

This paper (so far): Our view + international trade

- Model: Lagakos and Waugh (2011) + Eaton and Kortum (2002).
- Preliminary findings:
  - Less responsive trade flows, smaller trade costs.
  - More modest gains from trade.
- Why? Comparative advantage across sectors changes as a country opens.

Countries and Households

- J countries, indexed by j
- Countries differ in "economy-wide efficiency" A_j
- Each country has measure one of households, indexed by i

Households

Preferences

$$U^i = \log(c_a^i - \bar{a}) + \gamma \log(c_n^i).$$

Constraint

$$P_{aj} c_a^i + P_{nj} c_n^i \leq w_j^i, \quad \text{where} \quad w_j^i = \max\{\ w_{aj} z_a^i,\ w_{nj} z_n^i\ \},$$

$w_{aj},\ w_{nj}$ = wages per efficiency unit.

Endowment of "individual productivities"

$$\{z_a^i, z_n^i\} \sim G(z_a, z_n).$$

Final Goods

Production functions

$$y_a = \left[\int_0^1 q_a(\ell)^{\frac{\rho-1}{\rho}} d\ell\right]^{\frac{\rho}{\rho-1}} \quad \text{and} \quad y_n = \left[\int_0^1 q_n(\ell)^{\frac{\rho-1}{\rho}} d\ell\right]^{\frac{\rho}{\rho-1}}.$$

Run by competitive firms purchasing each variety ℓ from low cost supplier a la Eaton and Kortum (2002).

- Output prices P_{aj} and P_{nj}.

Intermediate Goods

Production functions of variety ℓ

$$q_{aj}(\ell) = x_a(\ell) A_j L_{aj}(\ell) \quad \text{and} \quad q_{n,j}(\ell) = x_n(\ell) A_j L_{nj}(\ell).$$

- Productivity, $x(\ell)$, is drawn from a Fréchet distribution $F(x) = \exp\left(x^{-\theta}\right)$.
- Effective labor inputs

$$L_a(\ell) \equiv \int_{i \in \Omega(a,\ell)} z_a^i \, dGi \quad \text{and} \quad L_n(\ell) \equiv \int_{i \in \Omega(n,\ell)} z_n^i \, dGi.$$

- Iceberg trade costs $\tau_{jk} \geq 1$, $\tau_{jj} = 1$.

Run by competitive producers with prices $p_{ajk}(\ell)$ and $p_{njk}(\ell)$ and paying wages per efficiency units w_{aj} and w_{nj}.

Equilibrium

Equilibrium:

- A competitive equilibrium consists of optimal decision rules, allocations of factors, and prices.
- That satisfy market clearing conditions and balanced trade.

Finding the $2 \times J$ wages per efficiency units is sufficient to solve the equilibrium.

Where Are We Going?

Rest of talk: worker productivities drawn from

$$G(z_a) = \exp\left(-z_a^{-\nu}\right) \quad \text{and} \quad G(z_n) = \exp\left(-z_n^{-\nu}\right).$$

Next several slides: Exploit this assumption and show...

- Closed economy labor productivity,
- Trade patterns,
- Welfare.

Then show some numerical examples.

Closed Economy Labor Productivity

Labor productivity in agriculture and non-agriculture in a closed economy

$$\frac{Y_{ak}}{N_{ak}} = A_k \mu_{ak}^{-\frac{1}{\nu}} \quad \text{and} \quad \frac{Y_{nk}}{N_{nk}} = A_k \mu_{nk}^{-\frac{1}{\nu}}$$

- μ_{ak} and μ_{nk} = share of labor in agriculture and non-agriculture in k.

Productivity in a sector rises as share of labor there falls—remaining workers are highly selected set.

- Lagakos and Waugh (2011): Agriculture shares differ greatly, selection leads to large productivity differences; vice versa in non-agriculture.

Remember this formula. It shows up in the next couple of slides.

Labor Shares and Trade Patterns...

Expenditure share of agriculture goods and non-agriculture goods in j from k

$$\pi_{ajk} = \frac{A_k^\theta \mu_{ak}^{-\frac{\theta}{\nu}} (\tau_{jk}\bar{w}_k)^{-\theta}}{\sum_{k=1}^{K} A_k^\theta \mu_{ak}^{-\frac{\theta}{\nu}} (\tau_{jk}\bar{w}_k)^{-\theta}} \quad \text{and} \quad \pi_{njk} = \frac{A_k^\theta \mu_{nk}^{-\frac{\theta}{\nu}} (\tau_{jk}\bar{w}_k)^{-\theta}}{\sum_{k=1}^{K} A_k^\theta \mu_{nk}^{-\frac{\theta}{\nu}} (\tau_{jk}\bar{w}_k)^{-\theta}}.$$

- $\bar{w}_k$ = average wage.

Some things to notice:

- As $\nu \to \infty$ the model converges to two sector Eaton and Kortum (2002).
- $\downarrow \mu_a$ increases competitiveness in supplying agriculture goods; decreases competitiveness in non-agriculture goods.
- This effect is amplified/dampend depending on how θ relates to ν.

Labor Shares and Trade Patterns...

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Here's our point:

- A poor country will want to import relatively more agriculture goods.
- But as it develops, labor shifts changing this pattern, i.e. its comparative advantage across sectors will change.
- This changes how trade responds relative to a standard model.

Labor Shares and Trade Patterns...

Expenditure share of agriculture goods and non-agriculture goods in j from k

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- $\bar{w}_k$ = average wage.

A stark example:

- Standard model: if $A_a << A_n$, the poor country opening will $\approx$ import all agriculture and export non-agriculture, i.e. go to a corner.
- Our model: This won't happen—relative productivities are changing as labor shifts preventing the move to a corner.

Aggregate Quantities and Welfare

Aggregate consumption of agriculture and non-agriculture:

$$C_{aj} = \frac{1}{1+\gamma}\left[A_j \mu_{aj}^{-\frac{1}{\nu}} \pi_{ajj}^{-\frac{1}{\theta}} + \gamma \bar{a}\right]$$

$$C_{nj} = \frac{\gamma}{1+\gamma}\left[A_j \mu_{nj}^{-\frac{1}{\nu}} \pi_{njj}^{-\frac{1}{\theta}}\right] - \frac{\bar{a}}{1+\gamma}\left[\left(\frac{\mu_a}{\mu_n}\right)^{\frac{1}{\nu}} \left(\frac{\pi_{ajj}}{\pi_{njj}}\right)^{\frac{1}{\theta}}\right]$$

Similar to Arkolakis, Costinot, and Rodríguez-Clare (2009).

- $\bar{a} = 0$, homothetic two sector version with heterogenous labor.
- As $\nu \to \infty$ this converges to ACR.

Aggregate Quantities and Welfare

Aggregate consumption of agriculture and non-agriculture:

$$C_{aj} = \frac{1}{1+\gamma}\left[A_j \mu_{aj}^{-\frac{1}{\nu}} \pi_{ajj}^{-\frac{1}{\theta}} + \gamma \bar{a}\right]$$

$$C_{nj} = \frac{\gamma}{1+\gamma}\left[A_j \mu_{nj}^{-\frac{1}{\nu}} \pi_{njj}^{-\frac{1}{\theta}}\right] - \frac{\bar{a}}{1+\gamma}\left[\left(\frac{\mu_a}{\mu_n}\right)^{\frac{1}{\nu}} \left(\frac{\pi_{ajj}}{\pi_{njj}}\right)^{\frac{1}{\theta}}\right]$$

Welfare gains from trade depends on how μ's and π's respond together.

- Hard to see exactly what's going on.
- Quantitative experiment should help.

Quantitative Analysis

We want to answer the following questions:

1. How do trade flows respond to changes in trade costs relative to a standard model?
2. How do the welfare gains from trade compare relative to a standard model?

The experiment today

- Three countries. Two rich and open, one poor and closed.
- Lower the poor country's trade costs and answer the questions.
- Compare to a standard model calibrated to the same moments—sectoral and aggregate productivity differences and sectoral labor shares.

Calibration

Common parameters:

- Preference parameters $\bar{a}$ and γ.
  - Picked to hit 2 percent of labor in agriculture in rich countries, 75 percent of labor in agriculture in (closed) poor country.
- The trade elasticity, $\theta = 4$, Simonovska and Waugh (2011).
- Rich country trade costs $= 2.50$.

Parameters specific to models:

- Our model: parameter $\nu = 5$ and A_{poor} so aggregate productivity difference $= 22$.
  - $\Rightarrow$ Ag / non-ag productivity difference of 40 and 14.
- Standard model: sectoral productivity differences A_a and A_n.
  - Match same sectoral productivity differences in our model.

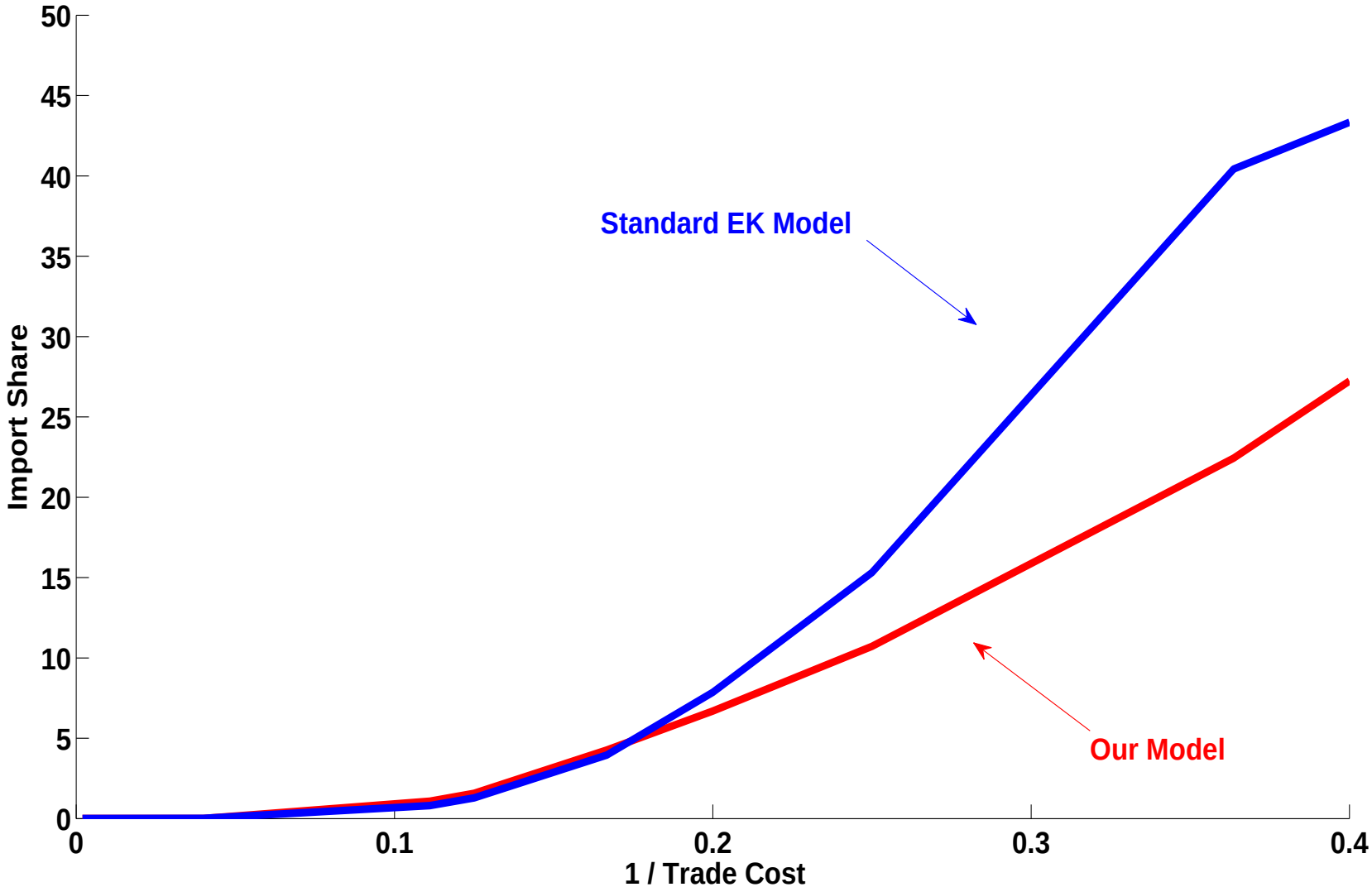
The Quantitative Experiment

Start with the poor country closed, i.e. $\tau_{poor,j}, \tau_{j,poor} = \infty$ and lower trade costs until they equal rich country trade costs.

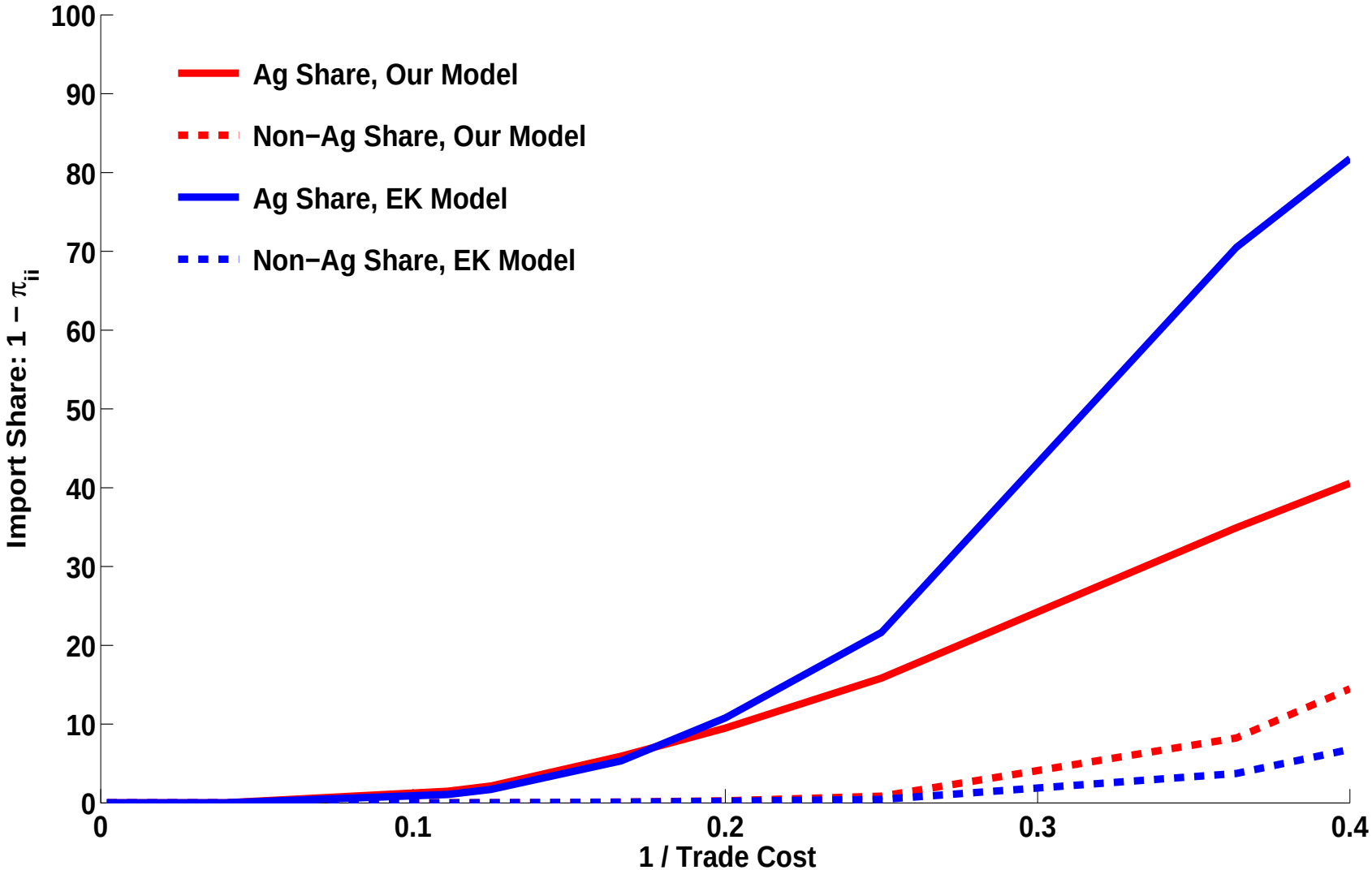
Next couple of slides:

- Trade flows.
- "Closed economy" productivity $A\mu_a^{-\frac{1}{\nu}}$ and $A\mu_n^{-\frac{1}{\nu}}$.
- Aggregate consumption and welfare.

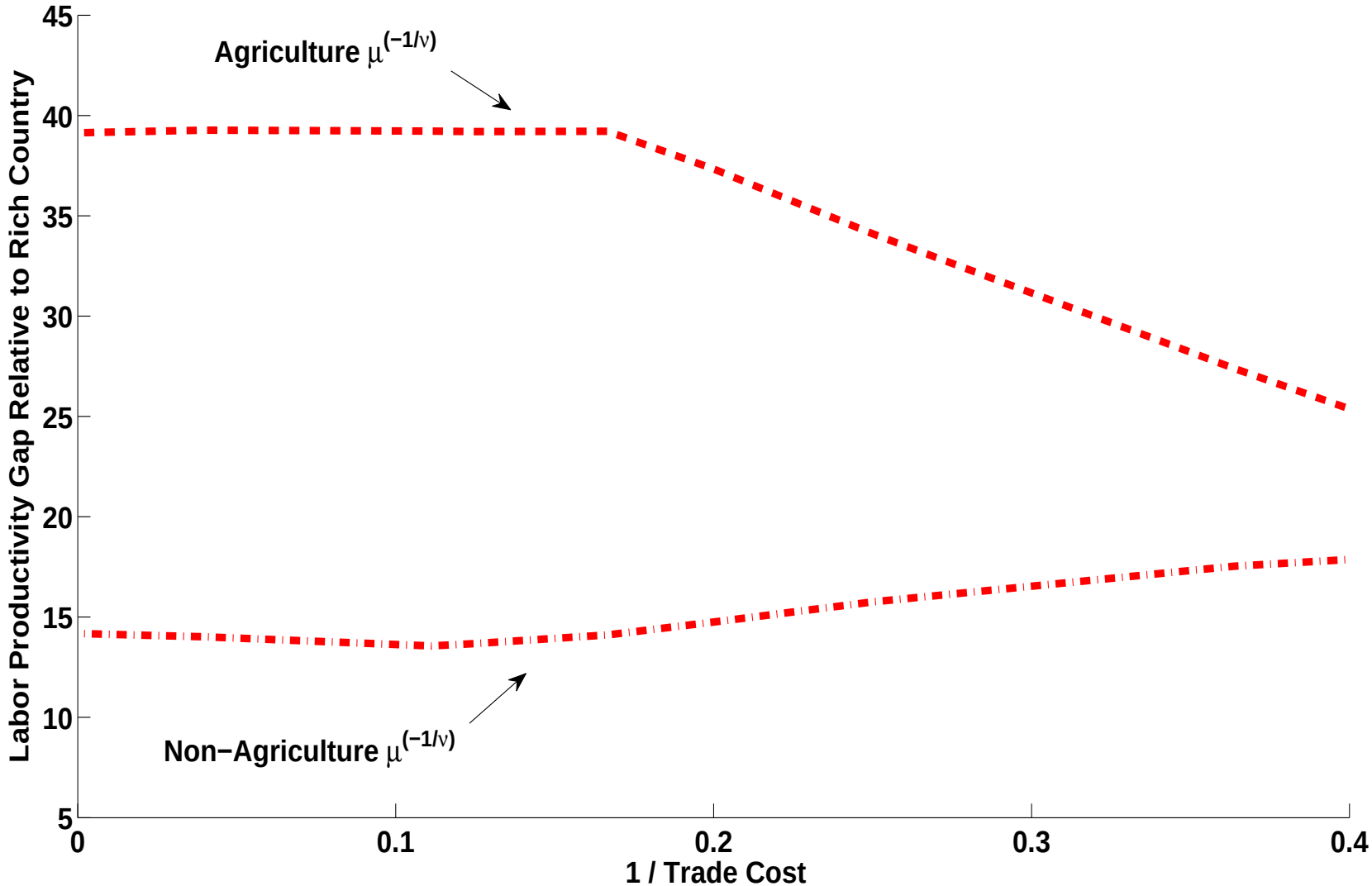
Imports / GDP


Import Share
50
45
40
35
30
25
20
15
10
5
0
0
0.1
0.2
0.3
0.4
1 / Trade Cost
Standard EK Model
Our Model

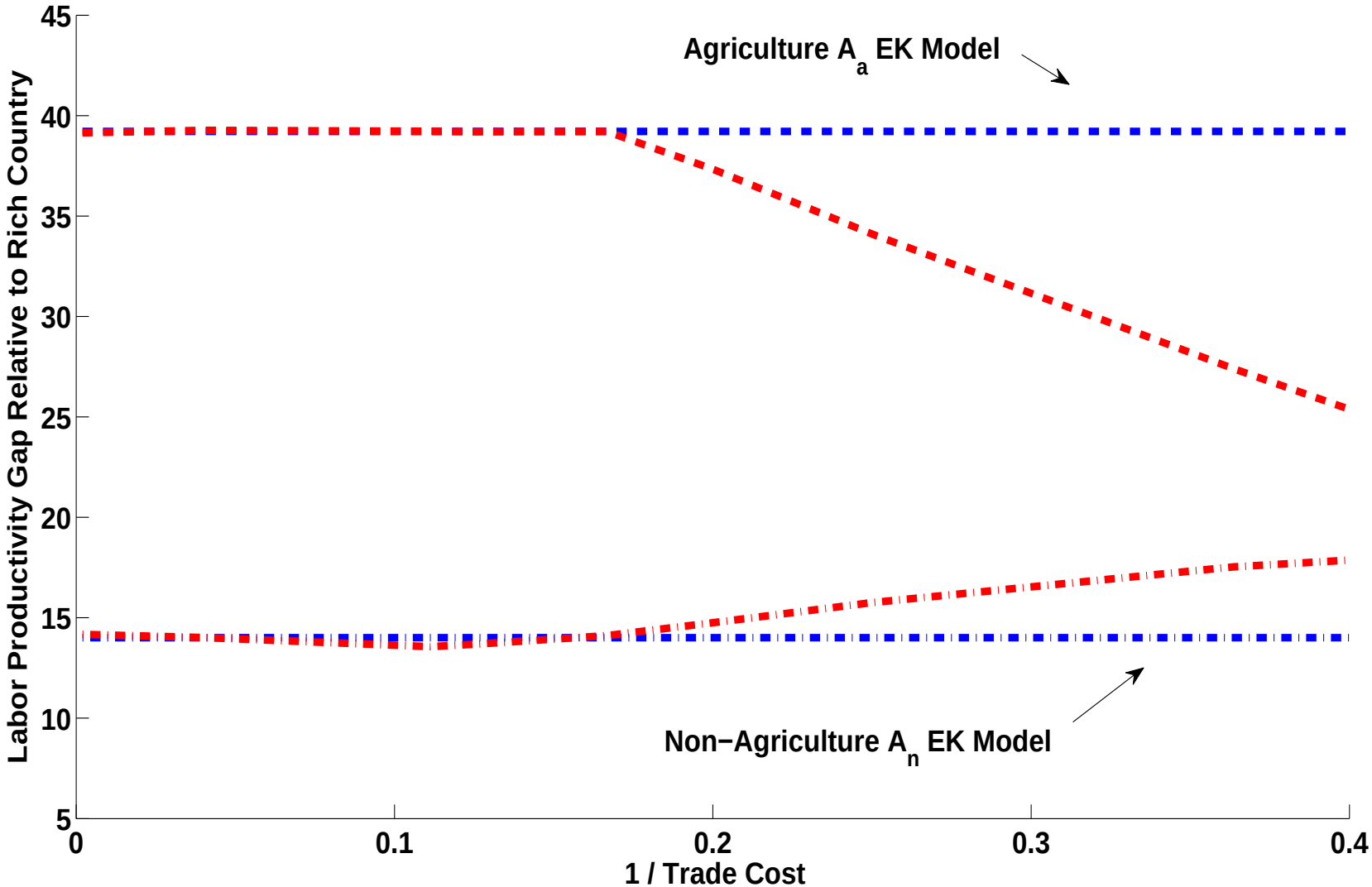
Import Shares Within Agriculture/Non-Agriculture



"Closed economy" Productivity — Our Model



"Closed economy" Productivity — Our Model and EK Model



Trade Flows Respond Less

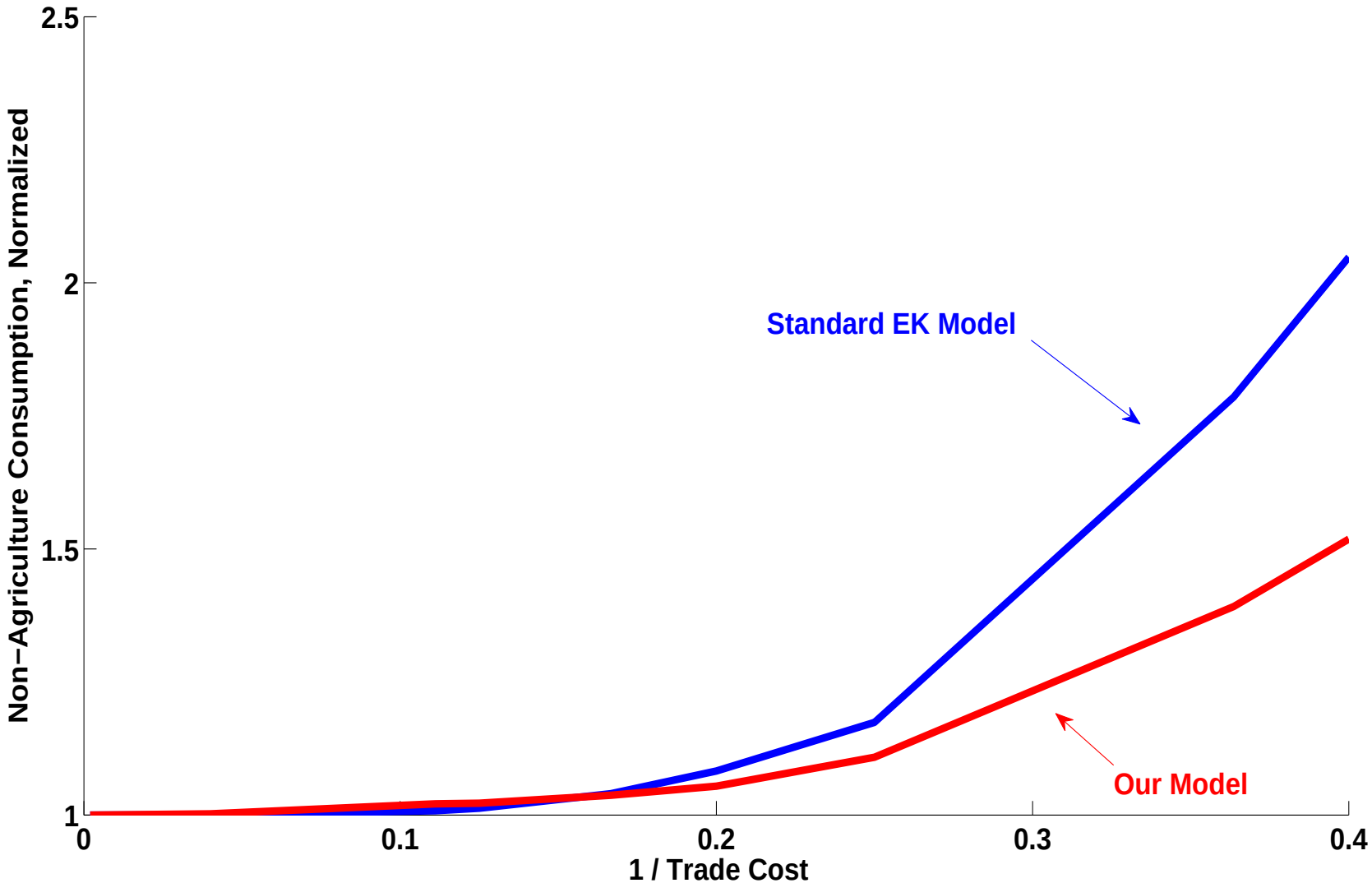
How do trade flows respond to changes in trade costs relative to a standard model? Much less. . .

- Aggregate trade is 60 percent larger in standard model.
- Agriculture trade is 233 percent larger in standard model.

Related question: What trade costs in standard model are needed to match trade flows in our model?

- 54 percent higher trade costs to match Imports/GDP
- 74 percent higher trade costs to match agriculture import share.

Aggregate Non-Agriculture Consumption



Welfare Gains Are Smaller

How do the welfare gains from trade compare relative to a standard model?

Measured as the percent increase in wages to compensate the representative consumer for a move to autarky.

- Our labor model $=$ 15 percent.
- Standard EK model $=$ 27 percent.

Welfare gains are 54 percent smaller.

Conclusions/Future Work

Still baking, but...

Trade in agriculture could lead to big gains for poor countries.

- Size of gains depend on extent to which poor countries can "scale up" non-agriculture production

What we did:

- Worker heterogeneity + selection forces suggest scaling up may be limited; trade flows respond less, gains from trade more modest