Skill Biased Heterogeneous Firms, Trade Liberalization and the Skill Premium

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Trade liberalization and inequality

Since 1970s many economies have experienced trade liberalization, trade growth (globalization) and increased inequality (skill premia).

We propose a new model that combines **skill bias of technology** with **trade liberalization** in a GE model of **heterogenous firms**.

- Designed to generate stylized facts on firm heterogeneity.
- Increase in skill premium after trade liberalization **unrelated to factor endowments or relative prices**:
  - not a Stolper-Samuelson mechanism, not HO, yet GE
  - w/trade patterns and factor content predictions as HO.

We highlight **changes in composition**, not with-firm changes.
- Exporters larger and more skill intensive, on average.
- Positive (imperfect) relationship between size and skill.
- Lots of heterogeneity, overlap.

Our model is designed to generate similar scatter plots.
Higher median for exporters, similar variance, overlap.
Variance within 4-digit industries is 50% higher than between.
Same for U.S.: Dunne, Foster, Haltiwanger and Troske ('04).

Our model is designed to generate similar distributions.

- \( w \equiv \) unskilled wage, \( s \equiv \) skilled wage.
- Cobb-Douglas production \( \Rightarrow \) unit costs in variable costs:

\[
c_v (\alpha, \varphi, s, w) = \frac{1}{\varphi} \phi_1 \phi_2^{1-\alpha} \equiv \phi
\]

- Entrants pay to draw \textbf{technology} \((\alpha, \varphi) \sim G(\alpha, \varphi)\).
  - Consider \( G(\alpha, \varphi) \) set of production possibilities.
  - Once drawn, technology \((\alpha, \varphi)\) is fixed.

- Given factor prices \( s \) and \( w \), some firms \( \phi \geq \phi^* \) survive, of which only the most competitive \( \phi \geq \phi^*_x > \phi^* \) export.

- Only \( \phi \) matters for \textbf{competitiveness}, and comes with heterogenous \( \varphi \) and \( \alpha \).

- \textbf{Technique} = \( H/L = \frac{\alpha}{1-\alpha} \left( \frac{s}{w} \right)^{-1} \) responds to factor prices.
Size, skill intensity and exporting in equilibrium

Positive skill premium $\Rightarrow$ upward sloping cutoffs (iso-cost curves).
What we do: consider correlation

\[ c_v(\alpha, \varphi, s, w) = \frac{1}{\varphi} s^\alpha w^{1-\alpha} \equiv \frac{1}{\phi} \]

Consider correl(\(\alpha, \varphi\)) > 0 (as implied by data):

- Positive association between skill, productivity and competitiveness.
- Interpretation: to produce more efficiently, must hire more engineers, on average.
- Result: Exporters are more skill intensive.

(When \(s > w\), conditional on \(\varphi\), higher \(\alpha\) is less competitive)
Fixed technology assumption

We highlight **changes in composition**, not within-firm changes.

- Consistent with findings in Bernard and Jensen (1997).

\[
c_v (\alpha, \varphi, s, w) = \frac{1}{\varphi} s^\alpha w^{1-\alpha} \equiv \frac{1}{\phi}
\]

We assume no effect of liberalization on firm $\alpha$ or $\varphi$:

- Simplification that allows general equilibrium analysis.
- *Trade-induced* upgrades in $\alpha$ are small (Bustos 2011).
- Haltiwanger, Lane and Spletzer (2007): firm level heterogeneity very persistent.
- Chilean data consistent with fixed $\alpha$. 
Heckscher-Ohlin tradition

Factor intensity in production related to preferences.

- Competition stronger among producers with same factor intensity than across producers with different intensities.
- Elasticity across varieties produced with same intensity $\eta > \epsilon$ elasticity across varieties produced with different intensities.
  - Standard HO competitive model: $\eta = \infty$
  - Dornbusch, Fischer, and Samuelson (1980): $\eta = \infty$, $\epsilon = 1$
  - Helpman and Krugman (1985): $\eta > 1$, $\eta > \epsilon$
  - Bernard, Redding and Schott (2007): $\eta > \epsilon = 1$

$\Rightarrow$ Trade liberalization has different effects on different industries depending on factor intensity $\Rightarrow$ Stolper-Samuelson effects.
What we do: separate preferences from production

Break with HO tradition: preferences over goods not related to goods’ factor intensity

- All firms compete head-to-head, regardless of skill intensity.
- Only $\phi$ matters for competitiveness, regardless of $\alpha$.
- Symmetry in demand: one elasticity of substitution $\sigma$ for all.

A more natural way to model preferences.

- Is competition stronger across or within skill categories?
- Data: $\text{Var}(\alpha)$ within $> 1.5 \times \text{Var}(\alpha)$ between industries.

$\Rightarrow$ Trade liberalization has same effect on all firms, regardless of firms’ skill intensity $\Rightarrow$ No Stolper-Samuelson effects, yet

- Trade patterns and factor content predictions as HO.
Symmetric effect on all firms

Sales

\[ r_d (\phi) = R_d (\rho P_d)^{\sigma-1} \phi^{\sigma-1} \]
\[ r_x (\phi) = \tau^{1-\sigma} R_x (\rho P_x)^{\sigma-1} \phi^{\sigma-1} \]

depend only on \( \phi \).

- Increase import competition: \( P_d \downarrow \) on impact.
- More export opportunities: \( \tau \downarrow \) on impact.
- Both affect all firms equally, regardless of skill intensity (\( \alpha \)).
Trade liberalization mechanism

As in Melitz (2003), with falling barriers:

- $\phi^* \uparrow$: least competitive firms exit (import competition).
- $\phi^*_x \downarrow$: some marginal non-exporters decide to export.
- Incumbent and new exporters expand, non-exporters retrench/exit.

If $\text{correl}(\alpha, \varphi) > 0$ (as in the data), then:

- Incumbent exporters: relatively skill intensive and expand.
- Non exporters: relatively skill un-intensive and contract.
- Aggregate demand for skill rises $\Rightarrow$ skill premium rises.

Caveat: Newest exporters less skill intensive than incumbents. When very open, further liberalization may lower skill demand.
$\tau_0 > \tau_1$. Skill premium increases $\Rightarrow$ cutoff slopes become flatter.
Two Asymmetric Countries
Asymmetric equilibrium

Two countries (A and B) identical except for endowments,

\[(H/L)^A > (H/L)^B \iff (s/w)^{A_{aut}} < (s/w)^{B_{aut}}\]

Choose \((H + L)^B\) so that \(Q^B = Q^A\) in autarky to avoid ex ante market size effects.

- A and B have same \(G(\alpha, \varphi)\).

No analytical results. Numerical solution challenging, equilibrium involves all endogenous variables simultaneously from both countries, including aggregates, e.g.,

\[
\phi_{x}^{a} = \phi_{x}^{a} \tau \left( \frac{P^a}{P^b} \right) \left( \frac{R^a f_x}{R^b f} \right)^{\frac{1}{\sigma-1}}.
\]

\[
P^a = \left[ M^a \left( \frac{1}{\rho \tilde{\phi}^a} \right)^{1-\sigma} + \chi^b M^b \left( \tau / \rho \tilde{\phi}_x^b \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}.
\]
Numerical Experiments
Parametrization of joint distribution

Marginal distributions

- $\varphi \sim \text{Pareto}(m, k)$. Standard.
- $\alpha \sim \text{Beta}(a, b)$. Restricts $\alpha \in [0, 1]$.

Given marginals, use Plackett copula to characterize

$$G(\alpha, \varphi) = C_\theta [B(\alpha), P(\varphi)],$$

where $P(\varphi)$ and $B(\alpha)$ are the marginal distributions.

- $\theta$ governs degree of association between $\alpha$ and $\varphi$.
- $G(\alpha, \varphi)$ has 5 parameters: $m, k, a, b, \theta$; Normalize $m = 1$.

Use minimum distance estimator (values of other parameters from the literature); estimates imply $\text{ex ante correl}(\alpha, \ln \varphi) \approx 0.6$. 
Tariff reduction in **Asymmetric** world: reals

Same as in Melitz (2003), but larger gains from trade in A.
Tariff reduction in **Asymmetric** world: prices

Skill premium rises, real wages rise, both in A and B.
Net Factor content of trade

We have a HO thm-like result (when $\tau > 1$ not mirror image).
$B$ is less competitive, more mediocre firms: Higher skill premium – endowment (supply) farther away from ideal (technology, demand) – taxes the most $\phi$-productive firms.
Skill abundance (endowment) convergence of B to A

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<th>(H/L)$^B$</th>
<th>country A</th>
<th>country B</th>
<th>B/A</th>
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<td>70.8</td>
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</tbody>
</table>

Big effects in B—little effects on A. Counteracting forces:

- B becomes more competitive ⇒ kills less productive A firms.
- B mkt size ↑ ⇒ easier for less productive A firms to survive.
Conclusions

1. Model: Two dimensional heterogenous firms in $\varphi$ and $\alpha$.
   - GE, but non Heckscher-Ohlin mechanism.
     - Breaks link between technology and preferences.
     - Does not rely on relative prices (no Stolper-Samuelson thm).
     - Predicts patterns/net factor content of trade (yes HO thm).

2. Model matches salient features of the data:
   - Estimate technology is skill biased: $\text{correl}(\alpha, \varphi) > 0$.
   - Exporters larger and more skill intensive, on average.
   - Lots of skill heterogeneity along size/exporting dimensions.

3. Trade liberalization generates increase in skill premium:
   - Both in identical and asymmetric countries.
   - Larger gains in more competitive (skill abundant) country.