Trade, Firm Selection, and Innovation: the Competition Channel

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CEPR ESSIM 2010
Motivating evidence

I. Selection effect: trade liberalization cleans the market of inefficient firms, thus raising the level of productivity
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II. Selection and innovation:
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- LLeiva and Trefler (2008), Canada-US Free Trade Agreement
- Teshima (2009), Mexican data
Motivating evidence ctd.

III. Pro-competitive effects of trade
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- Bugamelli, Fabiani, Sette (2008): import competition from China reduces prices and markups in Italian firms


Griffith, Harrison, and Simpson (2008), EU Single Market Program: increase in product market competition (reduction in avg. markups) and higher innovation (R&D)
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- Presents a theoretical model to jointly account for this set of empirical findings and perform quantitative analysis.
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  - Existing empirical and theoretical studies account for at most 2 of the 3 pieces of evidence

Why should we care?

- Micro-level studies cited focus specific channels of productivity improvements: evidence I-III needed a theory of the competition channel
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- Why should we care?

  - No consensus evidence on trade and growth with aggregate data (*Frenkel and Romer 1999, Rodriguez and Rodirk, 2000, Alcalà and Ciccone 2004*)
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- Incumbent firms invest in cost-reducing innovation
- Oligopolistic market structure: $M$ goods, each produced by $n$ firms competing Cournot
- **Endogenous market structure**: trade liberalization $\Rightarrow$ increase number of firms per variety $\rightarrow$ reduces markups $\rightarrow$ study it’s effects on selection and innovation
Related literature

- Trade, selection and **technology adoption**: Yeaple (2005), Costantini and Melitz (2007), Bustos (2007)
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  - Monopolistic competitive models (exogenous market structure) $\rightarrow$ no competition effect
Related literature ctd.

- Trade, selection and **pro-competitive** effects
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  - Melitz-Ottaviano (2008): endogenous markups from special preferences, no innovation
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- Trade, selection and **pro-competitive** effects
  - Melitz-Ottaviano (2008): endogenous markups from special preferences, no innovation
Trade liberalization → reduces markups ⇒ increases innovation via 2 effects:

- **Direct effect:** trade leads to a larger number of firms, which results in lower markups due to increased competition and lower incentive for cost-reducing innovation (no role for heterogeneity).

- **Dynamic selection effect:** lower markups lead to less productive firms exiting, resources reallocated to surviving firms, which increase their market share and incentives to innovate (heterogeneity matters!).

Quantitative analysis: calibrate to US data, growth decomposition of effect of 10
drop in variable trade costs. Overall growth effect sizable: More than 90%
attributable to dynamic selection (heterogeneity matters big time!!).
Preview of the results

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  - Overall growth effect sizable
  - More than 90% attributable to dynamic selection (**heterogeneity matters big time!!**)
Preferences

- Intertemporal utility

\[
\int_{0}^{\infty} (\ln X_t + \beta \ln Y_t) e^{-\rho t} dt
\]
Preferences

- Intertemporal utility

\[ \int_{0}^{\infty} (\ln X_t + \beta \ln Y_t) e^{-\rho t} dt \]

- \( Y_t \), homogeneous good, \( X_t \) composite good

\[ X_t = \left( \int_{0}^{M_t} x_{jt} \alpha dj \right)^{\frac{1}{\alpha}} \]
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- \( M_t \) mass of goods at time \( t \)
- Numeraire: \( Y_t \)
- Household endowment: 1 unit of \( Y_t \)
Each variety is produced by \( n \) identical oligopolistic firms (\( n \) exogenous)
Technology

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- Heterogeneity: each variety produced with different productivity parameter $\tilde{z}$
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- A firm with productivity $\tilde{z}$ operates technology

$$c(\tilde{z}_t)q_t + \lambda = y_t$$
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\( q \) units of variety \( \tilde{z} \) produced with \( y \)-units of homogeneous good

\( c(\tilde{z}_t) = \tilde{z}_t^{-\eta}, \eta > 0 \)
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- fixed cost $\lambda$
- R&D technology

$$\tilde{z}_t = A \tilde{z}_t h_t$$
Technology

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- fixed cost \( \lambda \)
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\[
\dot{\tilde{z}}_t = A \tilde{z}_t h_t
\]

- \( \tilde{z} \) is an externality defined later (needed to get sustained growth)
Firms compete Cournot, solving

\[
V_s = \max_{(q_t, h_t)_{s}} \int_{s}^{\infty} \left[ \left( p_t - c(z_t) \right) q_t - h_t - \lambda \right] e^{-(\rho+\delta)(t-s)} \, dt, \quad \text{st.}
\]

\[
p_t = \frac{E_t}{X_t^\alpha} x_t^{\alpha-1}
\]

\[
x_t = \hat{x}_t + q_t
\]

\[
\hat{z}_t = A \hat{z}_t h_t
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\[
\tilde{z}_s > 0,
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Production and Innovation: solving the game

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- taking as given production and average productivity of competitors \((\hat{x}_t, \hat{z}_t)\) and the aggregates \(E_t\) and \(X_t\), \(\delta\) exogenous exit rate
Symmetric equilibrium yields

\[ c(\tilde{z}_t) = \theta \frac{E_t L}{X_t^\alpha} x_t^{\alpha-1}, \]

where \( \theta = n_1 + \alpha n \) is the inverse of the markup, equal for all firms and industries.

Notice: the markup is determined by CES parameter \( \alpha \) and number of firms. 

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Notice: the markup is determined by CES parameter \( \alpha \) and number of firms \( n \)
Equilibrium innovation

- Innovation investment

\[ h_t = \eta c(\tilde{z}_t)q_t - \frac{(\rho + \delta)}{A} \]

\[ c(\tilde{z}_t)q_t = \theta e z / \tilde{z} \]
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- where \( e \equiv E / nM \), is expenditure per firm,
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- \( z \) is a measure of detrended productivity, \( z e^{gt} = \tilde{z}_t^{\eta} \), with \( g \) the growth rate of productivity (defined below)
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- Cost-reducing innovation \( \Rightarrow \) return to innovation proportional to **quantity** and depends on

Relative productivity: distance to the mean

More productive firms innovate more (Lentz and Mortensen, 2008, Aw, Roberts, Xu, 2008)

On competition: negatively on the markup \( (1 / \theta) \), positively on \( e \) Impullitti-Licandro (IMT-IAE)

Trade, firm selection, and innovation
Equilibrium innovation

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  - Relative productivity: distance to the mean \( \tilde{z} \) \( \Rightarrow \) more productive firm innovate more (Lentz and Mortensen, 2008, Aw, Roberts, Xu, 2008)
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Define externality as

\[ \hat{z} = \frac{\bar{z}}{z} \tilde{z} \]
Stationary productivity growth

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Stationary productivity growth

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  \[ \hat{z} = \frac{\bar{\hat{z}}}{\bar{z}} \]

- Positive spillover from more productive firms, \( \bar{z}/z \) (distance from the mean and innovation difficulty)

- This yields stationary symmetric growth rate
  \[ g = \frac{\dot{\bar{z}}}{\bar{z}} = \eta \theta e - \rho - \delta \]

  which allows a stationary distribution on productivity (in line with evidence)
Exit

- Exogenous exit: $\delta$
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- Endogenous exit: at entry firms draw productivity $z$ from initial distribution $F(z)$ making profits

$$\pi(z/\bar{z}) = (1 - \theta) ez/\bar{z} - \left( \eta \theta e - \frac{\rho + \delta}{A} \right) z/\bar{z} - \lambda.$$  

with

$$\bar{z}(z^*) = \frac{1}{1 - F(z^*)} \int_{z^*}^{\infty} zf(z) \, dz$$
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$$

with

$$
\bar{z}(z^*) = \frac{1}{1 - F(z^*)} \int_{z^*}^{\infty} zf(z) dz
$$

- The zero-profit condition defines the cutoff

$$
e = \frac{\lambda}{z^*/\bar{z}(z^*)} - \frac{\rho + \delta}{A} \frac{1}{1 - (1 + \eta)\theta}
$$

[downward sloping function in $(e, z^*)]$ $\rightarrow$ intuition

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Stationary equilibrium: entry

- There is a unit mass of goods, $1 - M$ are potential entrants ($n$ firms enter altogether)
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- New entrants draw an initial productivity from $F(z)$
- Stationary allocation implies

$$
(1 - M)(1 - F(z^*)) = \delta M
$$

[negative relation btw. $z^*$ and $M$]
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[negative relation btw. \(z^*\) and \(M\)]

- The equilibrium distribution is

\[
\mu(z) = \frac{f(z)}{(1 - F(z^*))}
\]

for \(z \geq z^*\)
Stationary equilibrium: market clearing

- Using $\mu(z)$ the mkt. clearing can be written as

$$\int_{z^*}^{\infty} \left( (1 + \eta) \theta e \frac{z}{\bar{z}} - \frac{\delta + \rho}{A} z/\bar{z} + \lambda \right) \mu(z) \, dz + \beta e = \frac{1}{nM}$$

\hspace{1cm} differentiated

\hspace{1cm} homogeneous
Stationary equilibrium: market clearing

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$$\int_{z^*}^{\infty} \left( \left( 1 + \eta \right) \theta e \frac{z}{\bar{z}} - \frac{\delta + \rho}{A} \frac{z}{\bar{z}} + \lambda \right) \mu(z) \, dz + \text{differentiated} \right) \mu(z) \, dz + \beta e \text{ homogeneous} = \frac{1}{nM}$$

- Our normalization allows nice aggregation [positive in ($e, \bar{z^*}$)]→ higher $M$ lower expenditure per variety

$$e = \frac{L}{nM(\bar{z^*})} + \frac{\rho + \delta}{A} - \lambda$$

(MC)
Stationary equilibrium: market clearing

- Using $\mu(z)$ the mkt. clearing can be written as

$$\int_{z^*}^{\infty} \left( (1 + \eta) \theta e z/\tilde{z} - \frac{\delta + \rho}{A} z/\tilde{z} + \lambda \right) \mu(z) \, dz + \underbrace{\beta e}_{\text{homogeneous}} = \frac{1}{nM}$$

- Our normalization allows nice aggregation [positive in $(e, \tilde{z}^*)]$ → higher $M$ lower expenditure per variety

$$e = \frac{L}{nM(\tilde{z}^*)} + \frac{\rho + \delta}{A} - \lambda$$

- **Proposition 1.** Under some parameter restrictions there exists a unique interior solution $(e, z^*)$ of (MC) and (EC)
Stationary equilibrium

\[ \lambda \left( \frac{z^e}{z_{\min}} - \frac{\rho + \delta}{A} \right) \frac{1}{1 - (1 + \eta)\theta} \]

\[ \frac{(1+\delta)L + \rho + \delta}{n} - \frac{\lambda}{\beta + (1+\eta)\theta} \]

\[ \lambda \left( \frac{z^e}{z_{\min}} - \frac{\rho + \delta}{A} \right) \frac{1}{1 - (1 + \eta)\theta} \]
Proposition 2: An increase in $\theta$ raises the productivity cutoff $z^*$ reduces $M$ and increases the growth rate $g$
Competition effect in closed economy

- **Proposition 2**: An increase in $\theta$ raises the productivity cutoff $z^*$ reduces $M$ and increases the growth rate $g$

- Aggregate growth

\[
g = \eta A \theta \left( \frac{E(z^*)}{M(z^*) n} \right) - \rho - \delta
\]

The two innovation effects:

- **Direct effect**: higher $\theta$) lower markup leads to higher efficiency
- **Selection effect**: higher $\theta$) higher $\tilde{z} = z^*$) resources reallocated from exiting to surviving firms (heterogeneity matters!!)

Impullitti-Licandro (IMT-IAE)
Proposition 2: An increase in $\theta$ raises the productivity cutoff $z^*$ reduces $M$ and increases the growth rate $g$

Aggregate growth

$$g = \eta A \theta \frac{E(z^*)}{M(z^*) n} - \rho - \delta$$

The two innovation effects:

- Direct effect: higher $\theta$ leads to higher efficiency, higher quantity produced (no role for heterogeneity)
- Selection effect: higher $\theta$ means higher $\tilde{z} = \mu(z^*)$, resources reallocated from exiting to surviving firms (heterogeneity matters!!)
Proposition 2: An increase in $\theta$ raises the productivity cutoff $z^*$ reduces $M$ and increases the growth rate $g$

Aggregate growth

$$g = \eta A \left( \theta \frac{E(z^*)}{M(z^*) n} - \rho - \delta \right)$$

The two innovation effects:

**Direct effect:** higher $\theta \Rightarrow$ lower markup leads to higher efficiency $\Rightarrow$ higher quantity produced (no role for heterogeneity)
**Proposition 2**: An increase in $\theta$ raises the productivity cutoff $z^*$ reduces $M$ and increases the growth rate $g$

- **Aggregate growth**

$$g = \eta A \theta \left( \frac{E(z^*)}{M(z^*) n} \right) - \rho - \delta$$

- **The two innovation effects**: 
  - **Direct effect**: higher $\theta \Rightarrow$ lower markup leads to higher efficiency $\rightarrow$ higher quantity produced (no role for heterogeneity)
  - **Selection effect**: higher $\theta \Rightarrow$ higher $\bar{z}^*$ $\Rightarrow$ resources reallocated from exiting to surviving firms (**heterogeneity matters!!**)
Trade equilibrium

- Two symmetric countries: same tech, preferences and products (complete overlap)
Trade equilibrium

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- Iceberg trade cost $\tau > 1$
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- Equilibrium: same (MC) and (EC) but with different markup

$$\theta^T = \frac{2n - 1 + \alpha}{n (1 + \tau)^2 (1 - \alpha)} \left[ \tau^2 (1 - n - \alpha) + n (2\tau - 1) + (1 - \alpha) \right]$$

$$\theta^T_{\text{max}} \equiv \frac{2n - 1 + \alpha}{2n} \quad \text{when } \tau = 1$$
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- Trade markup lower than closed economy

$$\theta^T - \theta = \frac{\tau (1 - \alpha)^2 - n (\tau - 1)^2 (n + \alpha - 1)}{n (1 + \tau)^2 (1 - \alpha)} > 0$$
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$$

- Distance decreasing in $\tau$
Trade liberalization

- No ‘pure’ market-size effect: double number of firms, double market size - double number of firms (complete overlap)
Trade liberalization

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Trade liberalization

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  - **Selection effect**: $\theta \rightarrow \hat{z}^*$ mkt. shares redistribute to more productive (innovative) firms
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Only competition effect: decreases markup ($\theta \rightarrow \tilde{z}^\ast$)

- **Selection effect**: $\theta \rightarrow \tilde{z}^\ast$ mkt. shares redistribute to more productive (innovative) firms
- **Direct competition effect**: $\theta \rightarrow$ surviving firms produce higher quantity
Quantitative analysis: calibration external

- Calibrate the model to match US aggregate and firm-level statistics: assume $z \sim P(z_{\text{min}}, \kappa)$

### Summary of Calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Moment Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>0.309</td>
<td>Elasticity of sub/markup</td>
<td>Ruhl (2008)</td>
</tr>
<tr>
<td>$\delta$</td>
<td>0.09</td>
<td>Enterprise death rate</td>
<td>US Census (2004)</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.34</td>
<td>Share non differentiated</td>
<td>Rauch (1999)</td>
</tr>
<tr>
<td>$n$</td>
<td>6</td>
<td>Elasticity of sub/markup</td>
<td>Basu (1994)</td>
</tr>
<tr>
<td>$\rho$</td>
<td>0.05</td>
<td>interest rate</td>
<td>Mehra-Prescott (2005)</td>
</tr>
<tr>
<td>$\eta$</td>
<td>0.0119</td>
<td>R&amp;D/GDP + Growth</td>
<td>CHS (2006)</td>
</tr>
<tr>
<td>$\lambda$</td>
<td>1.507</td>
<td>avg. firm size</td>
<td>Axtell (2001)</td>
</tr>
<tr>
<td>$\kappa$</td>
<td>2.621</td>
<td>std. firm productivity</td>
<td>BJEK (2003)</td>
</tr>
</tbody>
</table>
Trade liberalization

- Reduce trade cost $\tau$ by 10 percent:
Trade liberalization

- Reduce trade cost $\tau$ by 10 percent:
- Growth decomposition (direct and selection effect):

$$g_\tau = \frac{d g}{d \tau} = g^d_\tau + g^*_\tau$$

Direct effect  Selection effect

where

$$g^d_\tau = \frac{\partial g}{\partial \tau} \bigg|_{z^* = z^*} = \frac{\beta (1 - \beta) \eta A e}{\beta + (1 + \eta) \theta_\tau} \frac{d \theta_\tau}{d \tau}.$$  \hspace{1cm} (1)

and

$$g^*_\tau = g_\tau - g^d_\tau$$
Simulation results: 10% drop in trade costs

### Sensitivity Analysis: Double the Benchmark

<table>
<thead>
<tr>
<th></th>
<th>bench</th>
<th>$n = 12$</th>
<th>$\kappa = 5.24$</th>
<th>$\beta = 0.68$</th>
<th>$\delta = 0.18$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1/\theta_\tau$</td>
<td>$-0.0115$</td>
<td>$-0.0252$</td>
<td>$-0.0115$</td>
<td>$-0.0115$</td>
<td>$-0.0115$</td>
</tr>
<tr>
<td>$z^*$</td>
<td>$0.0421$</td>
<td>$0.0702$</td>
<td>$0.0206$</td>
<td>$0.0418$</td>
<td>$0.0421$</td>
</tr>
<tr>
<td>$1 - F(z^*)$</td>
<td>$-0.1026$</td>
<td>$-0.1630$</td>
<td>$-0.1013$</td>
<td>$-0.1019$</td>
<td>$-0.1026$</td>
</tr>
<tr>
<td>$\bar{y}$</td>
<td>$0.1148$</td>
<td>$0.1965$</td>
<td>$0.1124$</td>
<td>$0.1148$</td>
<td>$0.1147$</td>
</tr>
<tr>
<td>$</td>
<td>g_\tau</td>
<td>$</td>
<td>$0.1298$</td>
<td>$0.2334$</td>
<td>$0.1320$</td>
</tr>
<tr>
<td>$g_\tau^d$</td>
<td>4.2%</td>
<td>5.1</td>
<td>4.1</td>
<td>3.1</td>
<td>4</td>
</tr>
<tr>
<td>$g_\tau^*$</td>
<td>95.8%</td>
<td>94.9</td>
<td>95.9</td>
<td>96.9</td>
<td>96</td>
</tr>
</tbody>
</table>

Benchmark: $n = 6$, $\kappa = 2.62$, $\lambda = 1.5017$, $\beta = 0.34$, $\delta = 0.09$,
Comparison with existing empirical works

Table 3

<table>
<thead>
<tr>
<th>Comparison with empirical evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moments model</td>
</tr>
<tr>
<td>$1/\theta_\tau$</td>
</tr>
<tr>
<td>$1 - F(z^*)$</td>
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</table>

All effects are quantitatively close to those in empirical works:

- Elasticity of the markup to a reduction in $\tau$ is the interval between 0.1 and 0.4.
- Elasticity of innovation to a reduction in $\tau$ roughly falls in the interval between 1 and 2.4.

Existing works study only parts of our predictions. We provide a complete picture (all effects) and a specific economic mechanism (source of selection) as a guideline for future empirical work.
Comparison ctd.

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Extension: fixed export and entry cost

- Each firm pays a fixed cost $\phi$ to enter and get the productivity draw
  $\rightarrow$ endogenize $n$
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- Each firm pay a fixed cost $\phi$ to enter and get the productivity draw → endogenize $n$
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- To simplify matters we remove innovation and look at effect of trade on markups and cutoffs
Extension: fixed export and entry cost

- Each firm pay a fixed cost $\phi$ to enter and get the productivity draw $\rightarrow$ endogenize $n$
- In order to export firms pay an additional fixed cost $\lambda_x$
- To simplify matters we remove innovation and look at effect of trade on markups and cutoffs
- Reintroducing innovation in progress
Extension: fixed entry and export costs

- Fixed export cost $\lambda_x \rightarrow$ new cutoff $z^*_x$

$$\left(1 - \theta_\tau\right)e = \frac{\lambda + \lambda_x}{z^*_x} \left(\frac{1}{\bar{p} \theta_\tau}\right)^{\frac{\alpha}{1-\alpha}}, \tag{XC}$$

where the $\bar{p}$ is a weighted average of productivities

$$\bar{p} = \left(\theta^{\frac{\alpha}{1-\alpha}} \int_{z^*_x}^{\infty} z \mu(z) \, dz + \theta_\tau^{\frac{\alpha}{1-\alpha}} \int_{z^*_x}^{\infty} z \mu(z) \, dz\right)^{\frac{\alpha-1}{\alpha}},$$
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\[
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(XC)

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\bar{p} = \left( \theta \frac{\alpha}{1-\alpha} \int_{z_x^*}^{\infty} z \mu(z) dz + \theta \tau \frac{\alpha}{1-\alpha} \int_{z_x^*}^{\infty} z \mu(z) dz \right)^{\frac{\alpha-1}{\alpha}},
\]

- Domestic cutoff $z^*$

\[
(1 - \theta) e = \frac{\lambda}{z^*} \left( \frac{1}{\bar{p} \theta} \right)^{\frac{\alpha}{1-\alpha}},
\]

(EC2)
Combining (EC) and (XC), we get a linear relation between $z^*$ and $z_x^*$

$$\frac{z_x^*}{z^*} = \frac{1 - \theta}{1 - \theta^*_x} \left( \frac{\theta}{\theta^*_x} \right)^{\frac{\alpha}{1 - \alpha}} \frac{\lambda + \lambda_x}{\lambda}$$
Combining (EC) and (XC), we get a linear relation between $z^*$ and $z_x^*$

$$\frac{z_x^*}{z^*} = \frac{1 - \theta}{1 - \theta_\tau} \left( \frac{\theta}{\theta_\tau} \right)^{\frac{x}{1-x}} \frac{\lambda + \lambda_x}{\lambda}$$

with $z^* < z_x^*$ $\rightarrow$ only the most productive firms export
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- with $z^* < z_x^*$ $\rightarrow$ only the most productive firms export
- $d(z_x^*/z^*)/d\theta_\tau > 0$
Free entry implies that the expected value of the firm must be equal to the entry cost

$$(1 - F(z^*)) \frac{\bar{\pi}}{\rho + \delta} = \phi,$$

where the average profit is given by

$$\bar{\pi} = \int_{z^*}^{Z_x} \left[ (1 - \theta) e^{\theta \frac{\alpha}{1 - \alpha}} z \bar{p}^{\frac{\alpha}{1 - \alpha}} - \lambda \right] \mu(z) dz + \int_{z^*}^{\infty} \left[ (1 - \theta_\tau) e^{\theta_\tau \frac{\alpha}{1 - \alpha}} z \bar{p}^{\frac{\alpha}{1 - \alpha}} \right].$$
extension: fixed entry and export costs

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  \]

- Calibrate and solve it numerically
Trade liberalization

**Domestic Markup**

- 1.1298
- 1.1296
- 1.1294
- 1.1292
- 1.1290

**Export markup**

- 1.14
- 1.13
- 1.12

**Domestic Cutoff**

- 44.35
- 44.33
- 44.31
- 44.29
- 44.27

**Export Cutoff**

- 195
- 190
- 185
- 180
- 175
Trade Liberalization

Average sales of exporters

Average profits

Total number of firms, $n^3 M$

Impullitti-Licandro (IMT-IAE)
Trade, firm selection, and innovation
CEPR ESSIM 2010
Extension: results

- There are three effects of trade liberalization.

Basic economic mechanisms behind the direct and selection effects of trade liberalization on innovation are still operative and even stronger. The key intuitions:

- Reduction in $\tau$ reduces the markup of exporters, forcing the less productive among them to exit the market and the productivity cutoff $z_x$ to increase.
- Entry depends on average profits $\bar{\pi}$, and trade liberalization increases $\bar{\pi}$, which reduces domestic markup and increases domestic cutoff $z_x$.
Extension: results

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  - Positive effect on number of firms $n$ per good and a negative effect on the total number of firms $nM$.
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Impullitti-Licandro (IMT-IAE)
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- The key intuitions:
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  - Entry depends on avg. profits $\bar{\pi}$ and trade liberalization increases $\bar{\pi} \uparrow n \Rightarrow$ reduces domestic markup and increases domestic cutoff $z^*$
Policy implication: in rigid economies $\phi$ is high $\Rightarrow$ trade liberalization can be a substitute to competition policy in generating more competition (higher $n$)
**Conclusion**

- **Pro-competitive** effects of trade on selection and innovation from endogenous market structure, as in evidence i)-iii)

Quantitative analysis: reduction of trade costs has substantial effects on innovation through both the intensive and extensive margin (selection).

A new channel of welfare gains from trade: the competition channel produces static (not new) and dynamic (new) welfare gains (limited to steady-state).

Needed transitional dynamics

Many extensions: asymmetric countries and asymmetric liberalizations
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Heterogeneity across firms or industries?

- Meltiz (2003): monopolistic competition → 1 firm produces 1 variety → heterogeneity across varieties/firms

\[ H_{\text{industries}, M_{\text{varieties in each industries}}, n_{\text{firms in each varieties}}} \]
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- This paper: \( n \) firms produce perfectly substitutable goods with same productivity → heterogeneity takes places across varieties

\[
\prod_{h=1}^{H} \prod_{t=1}^{M} x_{\alpha hjt} d_{jt}^{\alpha}
\]

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  - If a Dixit-Stiglitz aggregate of varieties is an industrial sector → both models are models of industry and the economy would be represented by many of these industries

\[
\prod_{h=1}^{H} X_t = \prod_{h=1}^{H} \left( \int_0^{M_t} x_{jht}^\alpha dj \right)^{\frac{1}{\alpha}}
\]

\( H \) industries, \( M \) varieties in each industries, \( n \) firms in each varieties
Heterogeneity across firms or industries?

- Trade liberalization leads to exit of *varieties* in Melitz
Heterogeneity across firms or industries?

- Trade liberalization leads to exit of *varieties* in Melitz
- Trade liberalization leads to exit of *firms* (when n is endogenous) and *varieties* in our model