The Impact of Trade on Intra-Industry Reallocation and Aggregate Industry Productivity
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Empirical facts:

- More productive establishments are much more likely to export.

- Exposure to trade enhances growth opportunities of some firms while contribute to the downfall of others.

- Therefore, it reallocates market shares toward larger firms.

- Protection from trade shelter inefficient firms.
Introduction

Objective

- **Main Objective:** To build a dynamic industry model with heterogenous firm to analyze the intra-industry effects of international trade.


- **Contribution:** The model can summarize the main empirical facts under reasonable assumptions.

- Also, even though it is general equilibrium setting with firm heterogeneity, it remains highly tractable because a single sufficient statistic can summarize aggregates.
Results:

- The model predicts that exposure to trade will induce only the more productive firms to export.
- General equilibrium effects will expel the least productive firms.
- It will reallocate market shares to the most productive firms increasing aggregate productivity.
- Reduction of trade costs increase exports in the extensive margin (↑ # of firms exporting).
Agents

• Preferences are given by the Dixit-Stiglitz C.E.S utility over a continuum of goods $\omega$:

$$U = \left[ \int_{\omega \in \Omega} q(\omega)^\rho d\omega \right]^{1/\rho}, \quad 0 < \rho < 1$$

• Which implies the elasticity of substitution:

$$\sigma = \frac{1}{1 - \rho} > 1.$$  

• Defining an aggregate price: $P = \left[ \int_{\omega \in \Omega} p(\omega)^{1-\sigma} d\omega \right]^{-\frac{1}{1-\sigma}}$, we have the demand and expenditure:

$$q(\omega) = Q \left[ \frac{p(\omega)}{P} \right]^{-\sigma}, \quad r(\omega) = R \left[ \frac{p(\omega)}{P} \right]^{1-\sigma}$$
Production

- Continuum of firms producing a variety $\omega$ with technology: $l = f + q/\varphi$.

- They share the same fixed cost $f$ but have different productivity $\varphi$.

- Since each monopolistic firm faces a residual demand with constant elasticity $\sigma$, they all have the same pricing rule:
  \[ p(\varphi) = \frac{w}{\rho \varphi} \]  
  (1)

- where $w$ is the wage (further normalized to 1), $1/\rho$ the markup and $\varphi$ the MPL.

- Then, firms revenues and profits are:
  \[ r(\varphi) = R(P \rho \varphi)^{\sigma-1}, \quad \pi(\varphi) = \frac{R}{\sigma}(P \rho \varphi)^{\sigma-1} - f \]
Equilibrium and Aggregation

An equilibrium is characterized by a mass $M$ of firms and a distribution $\mu(\varphi)$ of productivity levels.

- In equilibrium the aggregate price level is:

$$ P = \left[ \int_{0}^{\infty} p(\varphi)^{1-\sigma} M \mu(\varphi) d\varphi \right]^{\frac{1}{1-\sigma}} $$

- We can rewrite as $P = M^{1/(1-\sigma)} p(\tilde{\varphi})$, where:

$$ \tilde{\varphi} = \left[ \int_{0}^{\infty} \varphi^{\sigma-1} \mu(\varphi) d\varphi \right]^{\frac{1}{1-\sigma}} $$

(2)

- Where $\tilde{\varphi}$ is a weighted average of the firm productivity level. It also represents aggregate productivity because it completely summarizes the relevant information in $\mu(\varphi)$ for the aggregate variables:

$$ Q = M^{1/\rho} q(\tilde{\varphi}), \quad R = PQ = Mr(\tilde{\varphi}), \quad \Pi = M\pi(\tilde{\varphi}) $$
Firm Entry and Exit

- **Enter:** Firms pay a fixed entry cost $f_e > 0$. Then, draw their productivity $\varphi$ from a common pdf $g(\varphi)$ with support $(0, \infty)$

- **Exit:** Endogenous exit $\rightarrow$ if they draw a low $\varphi$ so $\pi < 0$. Exogenous exit $\rightarrow$ die with probability $\delta$.

- We can define the value function of a firm as:

  $$v(\varphi) = \max \left\{ 0, \sum_{t=0}^{\infty} (1 - \delta)^t \pi(\varphi) \right\} = \max \left\{ 0, \frac{1}{\delta} \pi(\varphi) \right\}$$

- Thus, there exist a $\varphi^*$ s.t. $\pi(\varphi^*) = 0 \rightarrow$ zero cutoff profit condition (ZCP).
Firm Entry and Exit

• Given $\mu(\varphi)$, we can define aggregate productivity as function of the cutoff:

$$\tilde{\varphi}(\varphi^*) = \left[ \frac{1}{1 - G(\varphi^*)} \int_{\varphi^*}^{\infty} \varphi^{\sigma-1} g(\varphi) d\varphi \right]^{\frac{1}{1-\sigma}}$$

• Moreover, the ZCP implies a relationship between average profit and $\varphi^*$:

$$\pi(\varphi^*) = 0 \Leftrightarrow r(\varphi^*) = \sigma f \Leftrightarrow \bar{\pi} = f \left[ (\tilde{\varphi}(\varphi^*)/\varphi^*)^{\sigma-1} - 1 \right]$$

(3)

• Free Entry: The net value of entry is equal to the average profits minus the entry cost and must be 0 in equilibrium:

$$v_e = (1 - G(\varphi^*)) \frac{\bar{\pi}}{\delta} - f_e \Rightarrow \bar{\pi} = \frac{\delta f_e}{1 - G(\varphi^*)}$$

(4)
Equilibrium

**Figure 1.** Determination of the equilibrium cutoff $\varphi^*$ and average profit $\bar{\pi}$. 
Conclusion: Closed Economy

- **Welfare per worker**: Welfare is given by the real wage:
  \[ W = P^{-1} = M^{\frac{1}{1-\sigma}} \rho \tilde{\phi} \]

- Welfare only is higher in a larger country due to product variety.

- A representative firm model with productivity \( \tilde{\phi} \) and profit \( \bar{\pi} \) yields the same results.

- However, the R.F. model cannot induce changes in aggregate productivity due to exposure of trade. Melitz model can do it because of the reallocation effect.
Open Economy

• If there is no costs of trade, then the world is just a big country.

• Therefore, we add two types of cost: Per unit iceberg cost $\tau > 1$ and a fixed entry cost to sell in a foreign market $f_{ex} > 0$.

• We assume that there are $n$ symmetric countries and the firms decide to enter in a foreign market after they know their $\varphi$.

• For simplicity assume the firm pays an amortized per-period version of the entry cost: $f_x = \delta f_{ex}$.
• Pricing rules as before: $p_d(\varphi) = 1/\rho \varphi$ and $p_x(\varphi) = \tau/\rho \varphi$.

• Firm revenues now are (notice $r_d(\varphi) = R(P \rho \varphi)^{\sigma-1}$):

$$
r(\varphi) = \begin{cases} 
  r_d(\varphi) & \text{if does not export,} \\
  r_d(\varphi) + nr_x(\varphi) = (1 + n\tau^{1-\sigma})r_d(\varphi) & \text{if exports}
\end{cases}
$$

• Firm profits: $\pi(\varphi) = \pi_d(\varphi) + \max \{0, n\pi_x(\varphi)\}$, where:

$$
\pi_d(\varphi) = \frac{r_d(\varphi)}{\sigma} - f, \quad \pi_x(\varphi) = \frac{r_x(\varphi)}{\sigma} - f_x
$$

• Thus, there exist two cutoffs: $\varphi^*$ and $\varphi_x^*$ s.t. $\pi_d(\varphi^*) = 0$ and $\pi_x(\varphi_x^*) = 0$. Where $\varphi_x^* > \varphi^*$ if $\tau^{1-\sigma}f < f_x$. 
Aggregation

- Let $M$ denote the mass of incumbents firms in any country and define the ex-ante probability of export:
  
  $$p_x \equiv \frac{1 - G(\varphi^*)}{1 - G(\varphi^*)}.$$

- $M_x = p_x M$ then represents the mass of exporting firms. Also, $M_t = M + nM_x$ represents the total mass of varieties available.

- Using the same weighted average function defined in (2), the weighted average productivity of all firms:

  $$\tilde{\varphi}_t = \left\{ \frac{1}{M_t} \left[ M\tilde{\varphi}(\varphi^*)^{\sigma-1} + nM_x(\tau^{-1}\tilde{\varphi}(\varphi^*_x))^{\sigma-1} \right] \right\}^{\frac{1}{\sigma-1}} \tag{6}$$

- Again, the aggregate variables: $P = M_t^{1-\sigma} p(\tilde{\varphi}_t)$ and $R = M_t r_d(\tilde{\varphi}_t)$ are easily traceable by $\tilde{\varphi}_t$. 
Equilibrium

- The **free entry** condition does not change:
  \[ \bar{\pi} = \delta f_e / [1 - G(\varphi^*)] \].

- However, the **ZCP** curve shifts up! Notice:

  \[
  \bar{\pi} = \pi_d(\bar{\varphi}) + p_x n \pi_x(\tilde{\varphi}_x) \\
  = f \left[ \left( \frac{\tilde{\varphi}(\varphi^*)}{\varphi^*} \right)^{\sigma-1} - 1 \right] + p_x n f_x \left[ \left( \frac{\bar{\varphi}(\varphi^*_x)}{\varphi^*_x} \right)^{\sigma-1} - 1 \right]
  \]

- The ZCP also implies that: \( \varphi^*_x = \varphi^* \tau \left( \frac{f_x}{f} \right)^{\frac{1}{\sigma-1}} \).

- Since FE and ZCP defines a unique \( \varphi^* \) and \( \bar{\pi} \), once we have \( \varphi^* \), we can backup \( \tilde{\varphi}, \tilde{\varphi}_x, \tilde{\varphi}_t \) and all the other variables.
The Impact of Trade

- Using this framework we can compare the SS equilibrium in **autarky vs. trade** and study the impact of a **trade liberalization**: $\uparrow n, \downarrow \tau$ and $\downarrow f_e$.

- **Autarky vs. trade SS**: Since the ZCP shifts up $\Rightarrow \uparrow \varphi^*$ and $\uparrow \bar{\pi}$. But the effect is not uniform across firms.

- The open economy decrease the firm’s share of the domestic market, but the exporters make up for its loss. Market share reallocation $\rightarrow$ exporters!

$$r_d(\varphi) < r_a(\varphi) < r_d(\varphi) + nr_x(\varphi) \quad \forall \varphi \geq \varphi^*$$  \hspace{1cm} (7)

- Nevertheless, not all the exporters increase their profits. E.g. the firm with $\varphi_x^*$ has $\pi_x(\varphi_x^*) = 0$ but $\pi_d(\varphi_x^*) < \pi_a(\varphi_x^*)$.  

The Impact of Trade

- Firms $\varphi \in [\varphi_a, \varphi^*)$ die.

- Firms $\varphi \in [\varphi^*, \varphi_x)$ survive but lose market share.

- Firms $\varphi \in [\varphi_x, \infty)$ export and gain market share, but only the most productive incur a profit gain.

**Figure 2.**—The reallocation of market shares and profits.
The Impact of Trade

• How the reallocation mechanism really works? Because of the monopolistic competition and the CES utility, firms do not really compete against each other.

• However, they compete for the same source of labor! → The increase in labor demand by both the more productive firms and the new entrants rises the real wage!

• Remember the aggregate price level: \( P_a = M_a^{1-\sigma} / \rho \tilde{\varphi}_a \) and \( P_t = M_t^{1-\sigma} / \rho \tilde{\varphi}_t \).

• Usually (but not always!) \( M_t > M_a \), but the aggregate productivity always increase \( \tilde{\varphi}_t > \tilde{\varphi}_a \) ⇒ \( P < P_a \).

• Even if the number of varieties decrease, welfare always improve with trade!
Trade Liberalization

- $\uparrow n \Rightarrow \text{ZCP shifts up: } \bar{\pi} = \pi_d(\tilde{\varphi}) + p_x n \pi_x(\tilde{\varphi}_x).$ Same analysis as before: $\varphi^* > \varphi^*$ and $\varphi_x^* > \varphi_x^*$.

- $\downarrow \tau \Rightarrow \text{ZCP shifts up. However, now the change generates entry of new firms into the export market: } \varphi^* > \varphi^*$ and $\varphi_x^* < \varphi_x^*$.

- $\downarrow f_e \Rightarrow \text{Again } \varphi^* > \varphi^*$ and $\varphi_x^* < \varphi_x^*.$ But there is no change for the firms that already exported, only the new exporters increase their sales.

- Welfare increases in all the cases.
Conclusion

- This paper has described and analyzed a new transmission channel for the impact of trade on industry structure and performance.

- It shows that the induced reallocation between different firms generate changes in the aggregate environment that cannot be explained by a representative model.

- The model concludes that the exposure to trade induce reallocation toward the more efficient firms.

- Also, it provides evidence that any trade-enhance policy is welfare improving.
Appendix

- The conditional distribution of productivity:

\[
\mu(\varphi) = \begin{cases} 
\frac{g(\varphi)}{1-G(\varphi^*)} & \text{if } \varphi \geq \varphi^* \\
0 & \text{otherwise}
\end{cases}
\] (8)

- Average profit and revenues are also tied to $\varphi^*$:

\[
\bar{r} = r(\tilde{\varphi}) = \left[\frac{\tilde{\varphi}(\varphi^*)}{\varphi^*}\right]^{-1} r(\varphi^*), \quad \bar{\pi} = \pi(\tilde{\varphi}) = \left[\frac{\tilde{\varphi}(\varphi^*)}{\varphi^*}\right]^{-1} \frac{r(\varphi^*)}{\sigma} - f
\]

- Market clearing:

\[
(1 - G(\varphi^*)) M_e = \delta M, \quad L_p = R - \Pi, \quad L_e = M_e f_e = M \bar{\pi} = \Pi
\]