Selection, Reallocation, and Knowledge Spillover: Identifying the Productivity Gains from Multinational Activity

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**Introduction**

![Figure 1: The correlation between multinational activity and average productivity](image)

**Figure 1:** The correlation between multinational activity and average productivity
Figure 2: The correlation between increase in multinational activity and average productivity growth
Nations with greater openness to multinational activity exhibit, on average, higher productivity (Borensztein et al., 1998; Alfaro et al., 2004; Harrison and Rodriguez-Clare, 2010; Kose et al. 2010).
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This positive correlation, likely conditional on factors, is often attributed to knowledge spillovers whereby foreign multinationals generate positive productivity externalities to domestic firms.
There is, however, a less stressed, alternative explanation, centering on *firm selections*.

- Selection of multinational firms

Helpman et al. (2004) show that countries with greater openness to multinational activity attract firms that are, by selection, more productive. Greater multinational activity leads to tougher competition and market reallocation and allows only the most productive domestic firms to survive.
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  - Tougher selection forces the least productive to exit;
These mechanisms all imply a positive relationship between multinational activity and host-country productivity, but represent different causalities:

- **The self-selection of multinational firms**: higher average productivity reflects the productivity of self-selected multinational firms;

- **The selection of domestic firms and knowledge spillovers**: multinational activity causes higher average productivity. However,
  - Tougher selection forces the least productive to exit;
  - Knowledge spillovers create positive externalities.
The main objective of this paper is to disentangle the roles of selections and knowledge spillovers in the aggregate impact of multinational activity on host-country productivity and quantify their relative importances in aggregate productivity gains.
Introduction

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Disentangling selections and knowledge spillovers is crucial for identifying the sources of productivity gains and setting effective FDI and industrial policies.

- If increases in productivity are due to knowledge spillovers, special treatment to foreign multinationals may be justified;
- If increases in productivity are due to tougher domestic selection,
  - A more sensible policy would be to improve domestic labor and financial market conditions while eliminating regulatory barriers to facilitate gains from competition and resource reallocation.
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- We develop a standard model of monopolistic competition and heterogeneous firms, adapted from Melitz (2003) and Helpman et al. (2004), and a structural empirical framework to show that:
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We develop a standard model of monopolistic competition and heterogeneous firms, adapted from Melitz (2003) and Helpman et al. (2004), and a structural empirical framework to show that:

- Selections and knowledge spillovers can be distinguished by exploring their distinct predictions for the distributions of domestic firms.
Introduction

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The selection of domestic firms:
Competition from multinationals leads to market reallocations and an increase in the *cutoff productivity and revenue* (greater left truncation of the distributions);

Knowledge spillovers:
Knowledge spillovers induce a *rightward shift* of the productivity distribution, while the revenue distribution sees a weaker, or even leftward, shift.
Literature

Productivity spillovers from multinational to domestic firms:

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- Arnold and Javorcik (2009) and Guadalupe et al. (2011) account for the endogenous acquisition decisions of MNCs and still find significant productivity spillovers in acquired plants.
The market reallocation effects of multinational production:

- Aitken, Harrison, and Lipsey (1996) and Feenstra and Hanson (1997) find foreign multinational activity to increase industry wages and share of non-production workers in wage bills;


- Ramondo (2009) examines both knowledge spillover and domestic turnover and finds negative correlations between foreign MNC entry and domestic market shares in Chilean manufacturing plants.
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The productivity effect of resource allocation:

A growing strand of literature argues that how resources are allocated across heterogeneous establishments plays a crucial role in explaining productivity and income differences (e.g., Hsieh and Klenow, 2009; Alfaro et al, 2008).
Our paper is an effort to distinguish the roles of selection and knowledge spillover in the aggregate productivity effect of multinational activity.

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- Micro theoretical foundation to develop an empirical strategy that is able to distinguish their relative importance;
- Structural framework to quantify the magnitude of productivity gains associated with each effect;
- Cross-country analysis to evaluate how the knowledge spillover and selection effects may vary systematically across nations.
Model: Setup

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- Two identical countries, $H$ and $F$, and two sectors, one homogeneous (numeraire) and one differentiated.
- A continuum of firms in each country, each producing a different variety of the differentiated product and drawing a distinct productivity level $\theta$. 
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Given a CES utility function, the demand function is given by

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  - \( f_E, f_D, \) and \( f_M \): the units of capital (e.g., machinery) required in entry, domestic and foreign production;
  - \( f_M > f_D \) and a constant share of \( f_M \) is financed in the host country.
- Profit-maximizing price: \( p(\theta) = w/(\alpha \theta) \).
Domestic firms:

\[ \pi_D(\theta) = \frac{r_D(\theta)}{\varepsilon} - cf_D = \frac{E}{\varepsilon} \left( \frac{\alpha P \theta}{w} \right)^{\varepsilon-1} - cf_D. \]
Model

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Model

Domestic firm cutoff productivity:

\[ \pi_D(\theta_D) = 0 \implies \theta_D = \left( \frac{\varepsilon cf_D}{E} \right)^{\frac{1}{\varepsilon-1}} \left( \frac{w}{\alpha P} \right). \]
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- \( \theta_M > \theta_D \): the minimum productivity to survive is higher for foreign multinational firms than for domestic firms.
Knowledge spillovers from foreign multinational to domestic firms:

\[ \theta = \tau^{z_M} \cdot \theta_a \]

where \( z_M \) is an indicator of multinational entry.
Model: Equilibrium Conditions

- Zero cutoff profit conditions:

\[ r(\theta_D) = \varepsilon c_{f_D} \]
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Model: Equilibrium Conditions

- **Zero cutoff profit conditions:**
  \[
  r(\theta_D) = \varepsilon c f_D \\
  r(\theta_M) = \varepsilon c f_M.
  \]

- **Free entry condition:**
  \[
  \nu_E = 0 \implies \bar{\pi} = \frac{\delta c f_E}{\gamma_D},
  \]
  where \(\gamma_D \equiv 1 - G(\theta_D)\) is the ex-ante probability of survival after entry.
Model: Equilibrium Conditions

- Labor market clearing condition:

\[
N_D \left( \bar{r}_D + \gamma_M \bar{r}_M \right) / \alpha^{\varepsilon - 1} = L
\]

which yields the number of domestic firms, \( N_D \), the number of foreign firms \( N_M \), and the total number of firms in the domestic market \( N \).
Model: Equilibrium Conditions

- Labor market clearing condition:
  \[ N_D \left( \bar{r}_D + \gamma_M \bar{r}_M \right) / \alpha^{\varepsilon-1} = L \]
  which yields the number of domestic firms, \( N_D \), the number of foreign firms \( N_M \), and the total number of firms in the domestic market \( N \).

- Capital market clearing condition:
  \[ N_D \left( f_D + \gamma_M f_M + \delta f_E / \gamma_D \right) = K \]
  which yields the unit capital cost \( c \).
Model: The Impact of Multinational Activity

- The Selection of Domestic Firms:
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The Selection of Domestic Firms:

- **Domestic cutoff productivity:** $\theta_D = \left( \frac{\varepsilon c f_D}{E} \right)^{\frac{1}{\varepsilon-1}} \left( \frac{w}{\alpha P} \right) > \theta_A$

  ($A$ denotes ex-ante – before multinational entry)
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  - **Exits** for \( \theta_A < \theta < \theta_D \);
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    $(A\text{ denotes ex-ante – before multinational entry})$
  - **Exits** for $\theta_A < \theta < \theta_D$;
  - **Revenue:** $r_D(\theta)/\tau^{ZM(\varepsilon-1)}_\theta < r_A(\theta)$;
Model: The Impact of Multinational Activity

The Selection of Domestic Firms:

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  \((A \text{ denotes ex-ante – before multinational entry})\)
- Exits for \( \theta_A < \theta < \theta_D \);
- Revenue: \( r_D(\theta) / \tau^{\theta M}(\varepsilon - 1) < r_A(\theta) \);
- The above effects operate through domestic factor markets where increased factor demand by multinational firms bids up the real wage and capital price.
Model: The Impact of Multinational Activity

**Aggregate Productivity**

\[
\text{Domestic : } \tilde{\theta}_D \equiv \frac{1}{1 - G(\theta_D)} \left[ \int_{\theta_D}^{\infty} \theta^{\epsilon-1} g(\theta) d\theta \right] \frac{1}{\epsilon - 1} > \tilde{\theta}_A
\]

\[
\text{Foreign : } \tilde{\theta}_M \equiv \frac{1}{1 - G(\theta_M)} \left[ \int_{\theta_M}^{\infty} \theta^{\epsilon-1} g(\theta) d\theta \right] \frac{1}{\epsilon - 1} > \tilde{\theta}_D
\]

\[
\text{Aggregate : } \tilde{\theta} = \left\{ \frac{1}{N} \left[ N_D^{\epsilon-1} \tilde{\theta}_D^{\epsilon-1} + N_M^{\epsilon-1} \tilde{\theta}_M^{\epsilon-1} \right] \right\} \frac{1}{\epsilon - 1} > \tilde{\theta}_A
\]
Model: The Impact of Multinational Activity

- **Welfare**

\[
P = N^{\frac{1}{1-\varepsilon}} p\left(\tilde{\theta}\right) = N^{\frac{1}{1-\varepsilon}} \frac{W}{\alpha \tilde{\theta}}
\]

\[
W = \frac{E}{L} N^{\frac{1}{\varepsilon-1}} \alpha \tilde{\theta}.
\]

When there is an increase in total product variety \(N\), this effect, together with increased aggregate productivity \(\tilde{\theta}\), leads to an increase in welfare.
Figure 3: The productivity distribution before and after multinational entry.
Figure 4: The revenue distribution before and after multinational entry
Model

Figure 5: The revenue distribution before and after multinational entry
The Self-Selection of Multinational Firms

\[
\Pr \left[ z_M(\theta) = 1 \mid \theta > \theta_D \right] \\
= \Phi_{\theta > \theta_D} \left[ \ln \theta + \ln \left( E^{\frac{1}{\varepsilon - 1}} \alpha P / w \right) - \frac{1}{\varepsilon - 1} \ln (\varepsilon c f_M) > 0 \right].
\]
Model: Main Equations

- The Self-Selection of Multinational Firms

\[
\begin{align*}
\Pr \left[ z_M(\theta) = 1 \mid \theta > \theta_D \right] &= \Phi_{\theta > \theta_D} \left[ \ln \theta + \ln \left( E^{\frac{1}{\varepsilon - 1}} \alpha P / w \right) - \frac{1}{\varepsilon - 1} \ln (\varepsilon c f_M) > 0 \right].
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- **The Self-Selection of Multinational Firms**

  \[
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  \]

- **The Selection of Domestic Firms**
  - Survival: \( \Pr [z_D(\theta) = 1|z_A(\theta) = 1] = \Pr [\theta > \theta_D] \)
Model: Main Equations

- **The Self-Selection of Multinational Firms**

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\Pr [z_M(\theta) = 1 | \theta > \theta_D] = \Phi_{\theta > \theta_D} \left[ \ln \theta + \ln \left( E^{\frac{1}{\epsilon - 1}} \alpha P / w \right) - \frac{1}{\epsilon - 1} \ln (\epsilon c f_M) > 0 \right].
\]

- **The Selection of Domestic Firms**
  - Survival: \( \Pr [z_D(\theta) = 1 | z_A(\theta) = 1] = \Pr [\theta > \theta_D] \)
  - Cutoff productivity:

\[
\ln \theta_D - \ln \theta_A = \frac{1}{\epsilon - 1} \ln \frac{c}{c_A} + \ln \frac{P_A}{P}.
\]
Model: Main Equations

Capital Market Reallocation

\[ \ln r_D(\theta_D) - \ln r_D(\theta_A) = \ln \frac{C}{C_A}, \]

where \( q_A \) is the \textit{qth} percentile in the ex-ante distribution.

Knowledge Spillover

\[ \ln \theta(q_A) - \ln \theta(q_A) = \ln \frac{\tau}{\theta}. \]
Model: Main Equations

- **Capital Market Reallocation**
  \[
  \ln r_D(\theta_D) - \ln r_D(\theta_A) = \ln \frac{c}{c_A},
  \]

- **Labor Market Reallocation**
  \[
  \ln r_D(q_A) - \ln r_A(q_A) = (\varepsilon - 1) \left[ \ln \left( \frac{P}{P_A} \right) + \ln \tau_\theta \right]
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- **Knowledge Spillover**
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  \ln \theta(q_A) - \ln \theta_a(q_A) = \ln \tau_\theta.
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- Time-series financial information, which enables measuring firm total factor productivity over time;
- Broad country coverage, which makes it possible to investigate how the impact of multinational activity varies across nations.
Data

- Four categories of information:

  - Industry information including the 4-digit NAICS code of the primary industry;
  - Ownership information including domestic and global parents and domestic and foreign subsidiaries;
  - Location information;
  - Financial information including revenue, employment, asset, and investment.

A firm is considered foreign owned if its global ultimate owner is based in a different country. There are about 36,000 foreign owned manufacturing subsidiaries in the final sample.
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- We consider two sub-periods: 2002–2004 and 2005–2007 and investigate how changes in multinational activity between the two periods affect host-country domestic firms.
Empirical Evidence

The Self-Selection of Multinational Firms

\[
\Pr \left[ z_M(\theta) = 1 | \theta > \theta_D \right] = \Phi_{\theta > \theta_D} \left[ \ln \theta - \ln \theta_M > 0 \right]
\]

\[
= \Phi_{\theta > \theta_D} \left[ \ln \theta + FE_M - \frac{1}{\varepsilon - 1} \ln d > 0 \right].
\]

- \( FE_M \): Country-industry fixed effects;
Empirical Evidence

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\[ \Pr [z_M(\theta) = 1 | \theta > \theta_D] = \Phi_{\theta > \theta_D} \left[ \ln \theta - \ln \theta_M > 0 \right] \]

\[ = \Phi_{\theta > \theta_D} \left[ \ln \theta + FE_M - \frac{1}{\varepsilon - 1} \ln d > 0 \right]. \]

- \( FE_M \): Country-industry fixed effects;
- \( d \): bilateral geographic factors
Empirical Evidence

The Self-Selection of Multinational Firms

\[
\text{Pr} \left[ z_M(\theta) = 1 \mid \theta > \theta_D \right] = \Phi_{\theta > \theta_D} \left[ \ln \theta - \ln \theta_M > 0 \right] = \Phi_{\theta > \theta_D} \left[ \ln \theta + FE_M - \frac{1}{\varepsilon - 1} \ln d > 0 \right].
\]

- \( FE_M \): Country-industry fixed effects;
- \( d \): bilateral geographic factors
- \( \theta \): the \textbf{ex-ante, headquarter} productivity of multinational firms
Empirical Evidence

The Self-Selection of Multinational Firms

\[
\Pr [z_M(\theta) = 1|\theta > \theta_D] = \Phi_{\theta > \theta_D} [\ln \theta - \ln \theta_M > 0] \\
= \Phi_{\theta > \theta_D} \left[ \ln \theta + FE_M - \frac{1}{\varepsilon - 1} \ln d > 0 \right].
\]

- \(FE_M\): Country-industry fixed effects;
- \(d\): bilateral geographic factors
- \(\theta\): the \textbf{ex-ante, headquarter} productivity of multinational firms
  - Expected to have an important effect on the investment decision of foreign firms, but less likely to be directly correlated with the future productivity of domestic firms
Empirical Evidence

The Selection of Multinational Firms

\[
\Pr [z_M(\theta) = 1 | \theta > \theta_D] = \Phi_{\theta > \theta_D} [\ln \theta - \ln \theta_M > 0] \\
= \Phi_{\theta > \theta_D} \left[ \ln \theta + FE_M - \frac{1}{\varepsilon - 1} \ln d > 0 \right].
\]

Based on the estimated parameters, we obtain:

- the expected probability of entry: \( \hat{\Pr} [\theta > \theta_M | \theta > \theta_D] \);
Empirical Evidence

The Selection of Multinational Firms

\[
\Pr [z_M(\theta) = 1|\theta > \theta_D] = \Phi_{\theta > \theta_D} \left[ \ln \theta - \ln \theta_M > 0 \right]
\]
\[
= \Phi_{\theta > \theta_D} \left[ \ln \theta + FE_M - \frac{1}{\varepsilon - 1} \ln d > 0 \right].
\]

Based on the estimated parameters, we obtain:

- the expected probability of entry: \( \hat{\Pr} [\theta > \theta_M|\theta > \theta_D] \);
- the expected probability of new multinational activity in each host country and industry, i.e., \( \hat{\gamma}_M \);
Empirical Evidence

The Selection of Multinational Firms

\[
\Pr [z_M(\theta) = 1|\theta > \theta_D] = \Phi_{\theta > \theta_D} [\ln \theta - \ln \theta_M > 0]
\]

\[
= \Phi_{\theta > \theta_D} \left[ \ln \theta + FE_M - \frac{1}{\varepsilon - 1} \ln d > 0 \right].
\]

Based on the estimated parameters, we obtain:

- the expected probability of entry: \( \hat{\Pr} [\theta > \theta_M|\theta > \theta_D] \);
- the expected probability of new multinational activity in each host country and industry, i.e., \( \hat{\gamma}_M \);
- the expected productivity of multinational firms, i.e., \( \hat{\theta}_M \).
Empirical Evidence

Table 1: The Self-Selection of Multinational Firms

<table>
<thead>
<tr>
<th>Dependent var.:</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MNC entry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HQ TFP</td>
<td>0.004***</td>
<td>0.004***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Distance</td>
<td>-0.003***</td>
<td>-0.007***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Contiguity</td>
<td>0.06***</td>
<td>0.06***</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Language</td>
<td>0.03***</td>
<td>0.03***</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.004)</td>
</tr>
<tr>
<td>Host country-ind FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>HQ country-ind FE</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Firm cluster</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>907,776</td>
<td>907,776</td>
</tr>
<tr>
<td>R square</td>
<td>0.08</td>
<td>0.08</td>
</tr>
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</table>
Multinational Activity and Average Productivity

Table 2: Multinational Activity and Average Productivity

<table>
<thead>
<tr>
<th>Dependent var.:</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in ---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MNC entry (predicted)</td>
<td>0.05*</td>
<td>0.02**</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>Host country FE</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Industry FE</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>60</td>
<td>2,814</td>
</tr>
<tr>
<td>R square</td>
<td>0.20</td>
<td>0.37</td>
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</tbody>
</table>
Empirical Evidence

The Selection of Domestic Firms: Survival

Table 3: The Survival of Domestic Firms

<table>
<thead>
<tr>
<th>Dependent var.:</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic firm survival</td>
<td>-0.001***</td>
<td>-0.001***</td>
</tr>
<tr>
<td>MNC entry (predicted)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>TFP (lagged)</td>
<td>0.002*** (\text{(0.000)})</td>
<td></td>
</tr>
<tr>
<td>Employment (lagged)</td>
<td>0.005*** (\text{(0.000)})</td>
<td></td>
</tr>
<tr>
<td>Country FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Industry FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Country-Industry cluster</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>548,249</td>
<td>548,249</td>
</tr>
<tr>
<td>R square</td>
<td>0.15</td>
<td>0.18</td>
</tr>
</tbody>
</table>
Empirical Evidence

The Selection of Domestic Firms: Cutoff Productivity

\[
\ln \theta_D - \ln \theta_A = \left( \frac{1}{\varepsilon - 1} \ln \frac{c}{c_A} + \ln \frac{P_A}{P} \right) z_M
\]

Capital Market Reallocation

\[
\ln r_D(\theta_D) - \ln r_D(\theta_A) = \left( \ln \frac{c}{c_A} \right) z_M
\]
Empirical Evidence

Table 4: The Cutoffs of Domestic Firms

<table>
<thead>
<tr>
<th>Dependent var.:</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in ---</td>
<td>Cutoff TFP</td>
<td>Cutoff revenue</td>
</tr>
<tr>
<td>MNC entry (predicted)</td>
<td>0.16*</td>
<td>0.06***</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>Host country FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Industry FE</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>2,819</td>
<td>3,408</td>
</tr>
<tr>
<td>R square</td>
<td>0.38</td>
<td>0.43</td>
</tr>
</tbody>
</table>
Empirical Evidence

Labor Market Reallocation

\[ \ln r_D(q_A) - \ln r_A(q_A) = (\varepsilon - 1) \left[ \ln \left( \frac{P}{P_A} \right) + \ln \tau_\theta \right] z_M \]

Knowledge Spillovers

\[ \ln \theta(q_A) - \ln \theta_a(q_A) = (\ln \tau_\theta) z_M. \]
Table 5: The Distributions of Domestic Firms

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>25th Percentile</td>
<td>50th Percentile</td>
<td>75th Percentile</td>
</tr>
<tr>
<td>MNC entry (predicted)</td>
<td>0.03* (0.02)</td>
<td>0.04*** (0.01)</td>
<td>-0.00 (0.01)</td>
</tr>
<tr>
<td>Host country FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Industry FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>2,313</td>
<td>2,313</td>
<td>2,313</td>
</tr>
<tr>
<td>R square</td>
<td>0.14</td>
<td>0.15</td>
<td>0.13</td>
</tr>
</tbody>
</table>

Panel A: TFP of different percentiles

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MNC entry (predicted)</td>
<td>-0.05*** (0.01)</td>
<td>-0.03* (0.02)</td>
<td>-0.002 (0.02)</td>
</tr>
<tr>
<td>Host country FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Industry FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>3,773</td>
<td>3,773</td>
<td>3,773</td>
</tr>
<tr>
<td>R square</td>
<td>0.19</td>
<td>0.17</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Panel B: Revenue of different percentiles
Table 6: Estimated Effects of Multinational Activity

<table>
<thead>
<tr>
<th>Variables</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutoff productivity</td>
<td>0.16</td>
</tr>
<tr>
<td>Cutoff revenue/Financing cost</td>
<td>0.06</td>
</tr>
<tr>
<td>Aggregate real price</td>
<td>-0.10</td>
</tr>
<tr>
<td>Revenue -- 25th perc.</td>
<td>-0.05</td>
</tr>
<tr>
<td>Revenue -- 50th perc.</td>
<td>-0.03</td>
</tr>
<tr>
<td>Revenue -- 75th perc.</td>
<td>0.00</td>
</tr>
<tr>
<td>Knowledge spillovers -- 25th perc.</td>
<td>0.03</td>
</tr>
<tr>
<td>Knowledge spillovers -- 50th perc.</td>
<td>0.04</td>
</tr>
<tr>
<td>Knowledge spillovers -- 75th perc.</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Quantifying Productivity Gains

Aggregate Productivity Gain:

\[
\Delta \tilde{\theta} \equiv \frac{\tilde{\theta}}{\tilde{\theta}_A} - 1 = \left\{ \frac{1}{1 + \gamma_M} \left[ \frac{\tilde{\theta}_D + \gamma_M \tilde{\theta}_M}{\tilde{\theta}_A} \right] \right\} - 1,
\]

where \( \tilde{\theta}_D, \tilde{\theta}_M, \tilde{\gamma}_D, \) and \( \tilde{\gamma}_M \) are used to proxy for \( \tilde{\theta}_D, \tilde{\theta}_M, N_D / N_A, \) and \( \gamma_M \), respectively.
Decomposition: Aggregate productivity gain consists of:

1. The selection of multinationals: $\Delta \tilde{\theta}_M = \frac{\tilde{\theta}_M}{\tilde{\theta}_A} - 1$. 
Decomposition: Aggregate productivity gain consists of:

1. The selection of multinationals: $\Delta \tilde{\theta}_M = \frac{\tilde{\theta}_M}{\tilde{\theta}_A} - 1$.

2. Productivity gain of domestic firms: $\Delta \tilde{\theta}_D \equiv \frac{\tilde{\theta}_D}{\tilde{\theta}_A} - 1$. 
Quantifying Productivity Gains

Decomposition: Aggregate productivity gain consists of:

1. The selection of multinationals: \( \Delta \tilde{\theta}_M = \frac{\tilde{\theta}_M}{\theta_A} - 1 \).
2. Productivity gain of domestic firms: \( \Delta \tilde{\theta}_D \equiv \frac{\tilde{\theta}_D}{\theta_A} - 1 \).

1. Market reallocations: \( \Delta \tilde{\theta}_D \bigg|_{\beta_\theta=0} = \frac{\tilde{\theta}_D}{\theta_A} \bigg|_{\beta_\theta=0} - 1 \).
Decomposition: Aggregate productivity gain consists of:

1. The selection of multinationals: $\Delta \tilde{\theta}_M = \frac{\tilde{\theta}_M}{\tilde{\theta}_A} - 1$.

2. Productivity gain of domestic firms: $\Delta \tilde{\theta}_D \equiv \frac{\tilde{\theta}_D}{\tilde{\theta}_A} - 1$.

   1. Market reallocations: $\Delta \tilde{\theta}_D \bigg|_{\beta_\theta=0} = \frac{\tilde{\theta}_D}{\tilde{\theta}_A} \bigg|_{\beta_\theta=0} - 1$.

   2. Knowledge spillovers: $\Delta \tilde{\theta}_D \bigg|_{\beta_p,\beta_c=0} = \frac{\tilde{\theta}_D}{\tilde{\theta}_A} \bigg|_{\beta_p,\beta_c=0} - 1$. 
Quantifying Productivity Gains

Table 7: Estimated TFP Gains

<table>
<thead>
<tr>
<th>TFP Gains</th>
<th>Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
</tr>
<tr>
<td>Aggregate</td>
<td>1.40</td>
</tr>
<tr>
<td>Multinational Firms</td>
<td>4.90</td>
</tr>
<tr>
<td>Domestic Firms</td>
<td>0.87</td>
</tr>
<tr>
<td>-- Spillover</td>
<td>0.60</td>
</tr>
<tr>
<td>-- Reallocation</td>
<td>0.27</td>
</tr>
</tbody>
</table>
Controlling for the role of trade, i.e., import growth and export growth;

Other TFP measures such as revenue per worker and TFP estimates based on Levinsohn and Petrin (2003);

The relationship between estimated TFP gains and country FDI promotion policies;

Between-industry knowledge spillovers and market reallocations.
A primary challenge in evaluating productivity gains from openness to multinational activity is to distinguish the roles of knowledge spillovers and selections.

We develop a theoretical and structural empirical framework to identify the relative importance of each source:

- Knowledge spillovers induce a rightward shift of the productivity distribution
- Selections cause a leftward shift of the revenue distribution and an increase in the cutoff productivity and revenue.

We find both knowledge spillovers and selections constitute important sources of productivity gains while their relative importance varies sharply across nations.
Cross-Country Heterogeneity

Table 8: Countries with the Highest Estimated TFP Gains

<table>
<thead>
<tr>
<th></th>
<th>Aggregate</th>
<th>Multinational</th>
<th>Domestic</th>
<th>Spillover</th>
<th>Reallocation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithuania</td>
<td>21.22</td>
<td>74.73</td>
<td>22.28</td>
<td>Lithuania</td>
<td>22.01</td>
</tr>
<tr>
<td>Norway</td>
<td>8.06</td>
<td>67.38</td>
<td>9.91</td>
<td>Norway</td>
<td>9.79</td>
</tr>
<tr>
<td>France</td>
<td>5.62</td>
<td>34.74</td>
<td>6.57</td>
<td>Bulgaria</td>
<td>6.28</td>
</tr>
<tr>
<td>Argentina</td>
<td>5.52</td>
<td>30.93</td>
<td>5.97</td>
<td>Argentina</td>
<td>5.73</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>5.50</td>
<td>23.84</td>
<td>4.75</td>
<td>Sweden</td>
<td>4.23</td>
</tr>
<tr>
<td>Sweden</td>
<td>4.99</td>
<td>23.58</td>
<td>3.00</td>
<td>Finland</td>
<td>2.63</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>3.67</td>
<td>23.44</td>
<td>2.77</td>
<td>Czech Rep.</td>
<td>2.47</td>
</tr>
<tr>
<td>Finland</td>
<td>2.90</td>
<td>23.06</td>
<td>1.13</td>
<td>Japan</td>
<td>0.82</td>
</tr>
<tr>
<td>Spain</td>
<td>1.93</td>
<td>22.63</td>
<td>0.95</td>
<td>Spain</td>
<td>0.60</td>
</tr>
<tr>
<td>Japan</td>
<td>1.68</td>
<td>20.43</td>
<td>0.90</td>
<td>France</td>
<td>0.42</td>
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</table>
### Table 9: Estimated TFP Gains and FDI Promotion Policies

<table>
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<tr>
<th></th>
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<th>Multinational</th>
<th>Domestic</th>
<th>Spillover</th>
<th>Reallocative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incentives</td>
<td>0.001</td>
<td>-0.23**</td>
<td>0.01</td>
<td>0.01</td>
<td>-0.001*</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.11)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Financial incentives</td>
<td>0.01</td>
<td>0.08</td>
<td>0.01</td>
<td>0.001</td>
<td>-0.001*</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(0.12)</td>
<td>(0.02)</td>
<td>(0.01)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Tax holiday</td>
<td>0.03</td>
<td>-0.35***</td>
<td>0.04*</td>
<td>0.04*</td>
<td>-0.001*</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.11)</td>
<td>(0.02)</td>
<td>(0.02)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Tax reduction</td>
<td>-0.003</td>
<td>-0.22*</td>
<td>-0.001</td>
<td>0.01</td>
<td>-0.000</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.12)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Regulation exemption</td>
<td>-0.02**</td>
<td>-0.17*</td>
<td>-0.01</td>
<td>-0.001</td>
<td>-0.001*</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.10)</td>
<td>(0.01)</td>
<td>(0.004)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Number of incentives</td>
<td>-0.004</td>
<td>-0.06**</td>
<td>-0.001</td>
<td>-0.000</td>
<td>-0.0002*</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.03)</td>
<td>(0.01)</td>
<td>(0.004)</td>
<td>(0.00)</td>
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</tbody>
</table>
Within- and Between-Industry Reallocations

Table 10: Within- and Between-Industry Reallocations

<table>
<thead>
<tr>
<th>Dependent var.:</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in ---</td>
<td>Cutoff TFP</td>
<td>Cutoff Revenue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MNC entry (predicted)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in the same industry</td>
<td>0.09***</td>
<td>0.15***</td>
<td>0.07***</td>
<td>0.05***</td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.03)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>in related industries</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-- Labor similarity</td>
<td>0.02***</td>
<td>-0.002</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.002)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-- Capital similarity</td>
<td>0.004</td>
<td></td>
<td>0.005***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td></td>
<td>(0.001)</td>
<td></td>
</tr>
<tr>
<td>Host country FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Industry FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
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<td>2,802</td>
<td>3,391</td>
<td>3,391</td>
</tr>
<tr>
<td>R square</td>
<td>0.37</td>
<td>0.36</td>
<td>0.33</td>
<td>0.33</td>
</tr>
</tbody>
</table>
## Table 11: Within- and Between-Industry Knowledge Spillovers (Developed Countries)

<table>
<thead>
<tr>
<th>Dependent var.:</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in TFP</td>
<td>25th Percentile</td>
<td>50th Percentile</td>
<td>75th Percentile</td>
</tr>
<tr>
<td>MNC entry (predicted) in the same industry</td>
<td>0.02</td>
<td>0.02*</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>(0.02)</td>
<td>(0.01)</td>
<td>(0.01)</td>
</tr>
<tr>
<td>in related industries</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-- Backward linkage</td>
<td>0.08**</td>
<td>0.05*</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td>(0.03)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>-- Forward Linkage</td>
<td>-0.15</td>
<td>-0.19</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
<td>(0.13)</td>
<td>(0.12)</td>
</tr>
<tr>
<td>Host country FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Industry FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Obs</td>
<td>1,057</td>
<td>1,057</td>
<td>1,057</td>
</tr>
<tr>
<td>R square</td>
<td>0.18</td>
<td>0.28</td>
<td>0.22</td>
</tr>
</tbody>
</table>