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

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Introduction

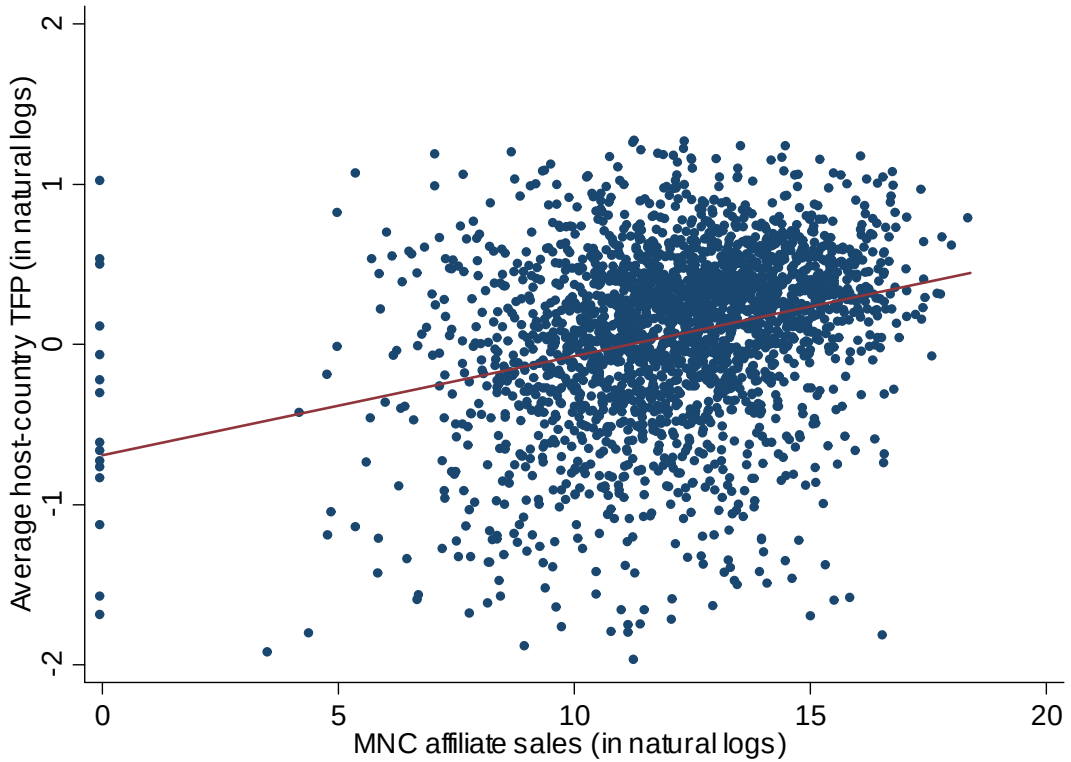

Figure 1: The correlation between multinational activity and average productivity

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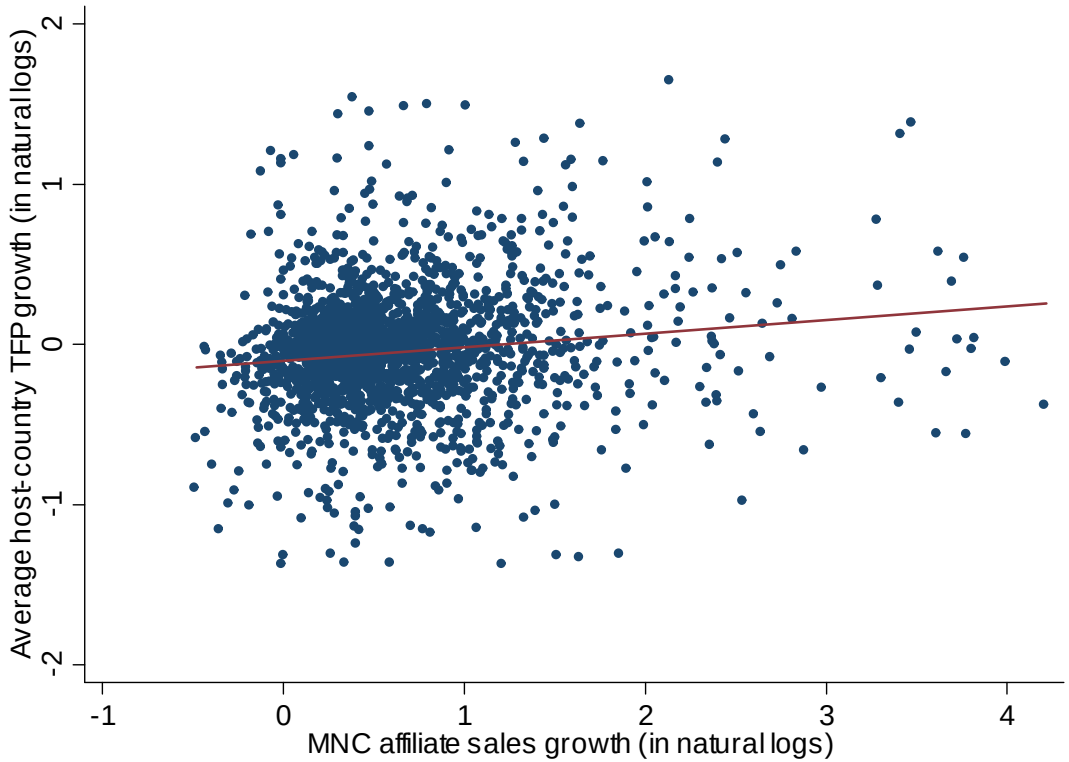

Figure 2: The correlation between increase in multinational activity and average productivity growth

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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.

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- 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.
- Selection of domestic firms
  - Greater multinational activity leads to tougher competition and market reallocation and allows only the most productive domestic firms to survive.

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- **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.

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- 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.

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

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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

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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.

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- 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.

Literature

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).

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- Micro theoretical foundation to develop an empirical strategy that is able to distinguish their relative importance;

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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.

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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 θ.

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  - $f_M > f_D$ and a constant share of f_M is financed in the host country.
- Profit-maximizing price: $p(\theta) = w/(\alpha\theta)$.

Model

- Domestic firms:

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- Domestic firm cutoff productivity:

$$\pi_D(\theta_D) = 0 \Longrightarrow \theta_D = \left(\frac{\varepsilon c f_D}{E}\right)^{\frac{1}{\varepsilon-1}} \left(\frac{w}{\alpha P}\right).$$

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- $\theta_M > \theta_D$: the minimum productivity to survive is higher for foreign multinational firms than for domestic firms.

Model

- Knowledge spillovers from foreign multinational to domestic firms:

$$\theta = \tau_{\theta}^{z_M} \cdot \theta_a$$

where z_M is an indicator of multinational entry.

Model: Equilibrium Conditions

- Zero cutoff profit conditions:

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- Free entry condition:

$$v_E = 0 \Longrightarrow \overline{\pi} = \frac{\delta cf_E}{\gamma_D},$$

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.

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- 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.

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  - **Revenue**: $r_D(\theta)/\tau_\theta^{z_M(\varepsilon-1)} < r_A(\theta)$;
  - 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**

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

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

$$\text{Aggregate} \quad : \quad \widetilde{\theta} = \left\{ \frac{1}{N} \left[N_D^{\varepsilon-1} \widetilde{\theta}_D^{\varepsilon-1} + N_M^{\varepsilon-1} \widetilde{\theta}_M^{\varepsilon-1} \right] \right\}^{\frac{1}{\varepsilon-1}} > \widetilde{\theta}_A$$

Model: The Impact of Multinational Activity

- **Welfare**

$$\begin{aligned} P &= N^{\frac{1}{1-\varepsilon}} p\left(\widetilde{\theta}\right) = N^{\frac{1}{1-\varepsilon}} \frac{w}{\alpha\widetilde{\theta}} \\ W &= \frac{E}{L} N^{\frac{1}{\varepsilon-1}} \alpha\widetilde{\theta}. \end{aligned}$$

When there is an increase in total product variety N, this effect, together with increased aggregate productivity $\widetilde{\theta}$, leads to an increase in welfare.

Model

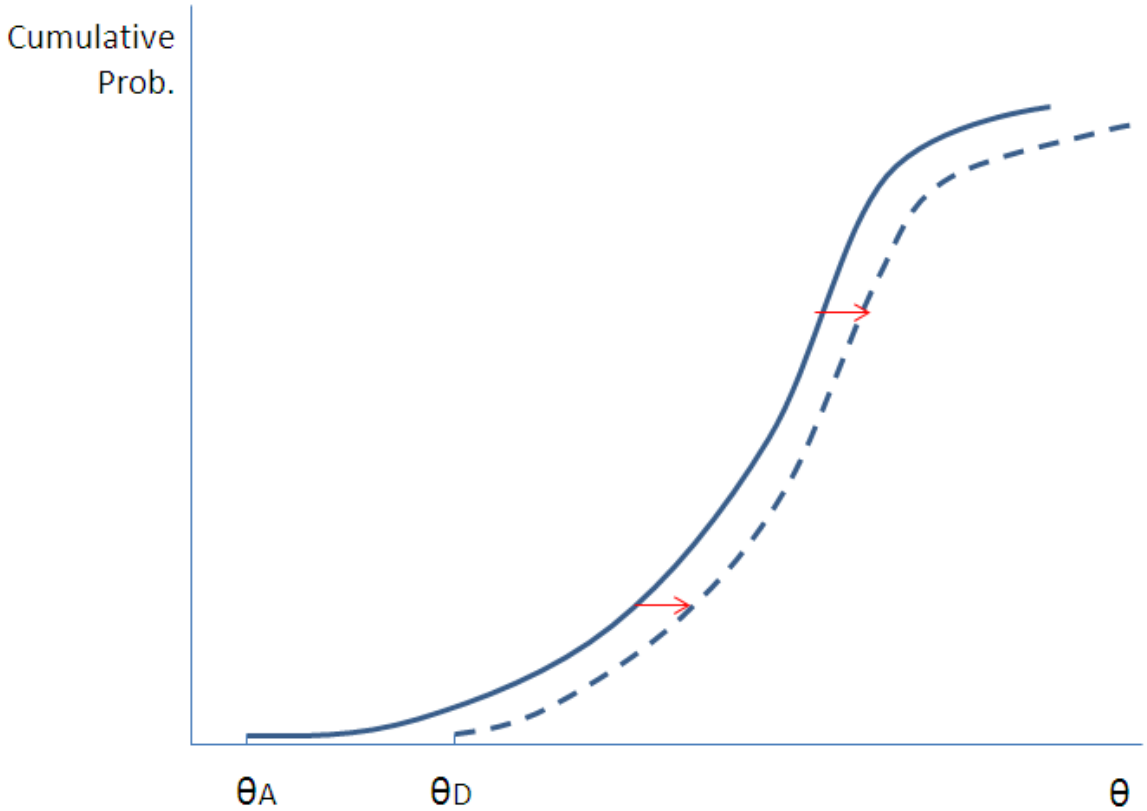

Figure 3: The productivity distribution before and after multinational entry

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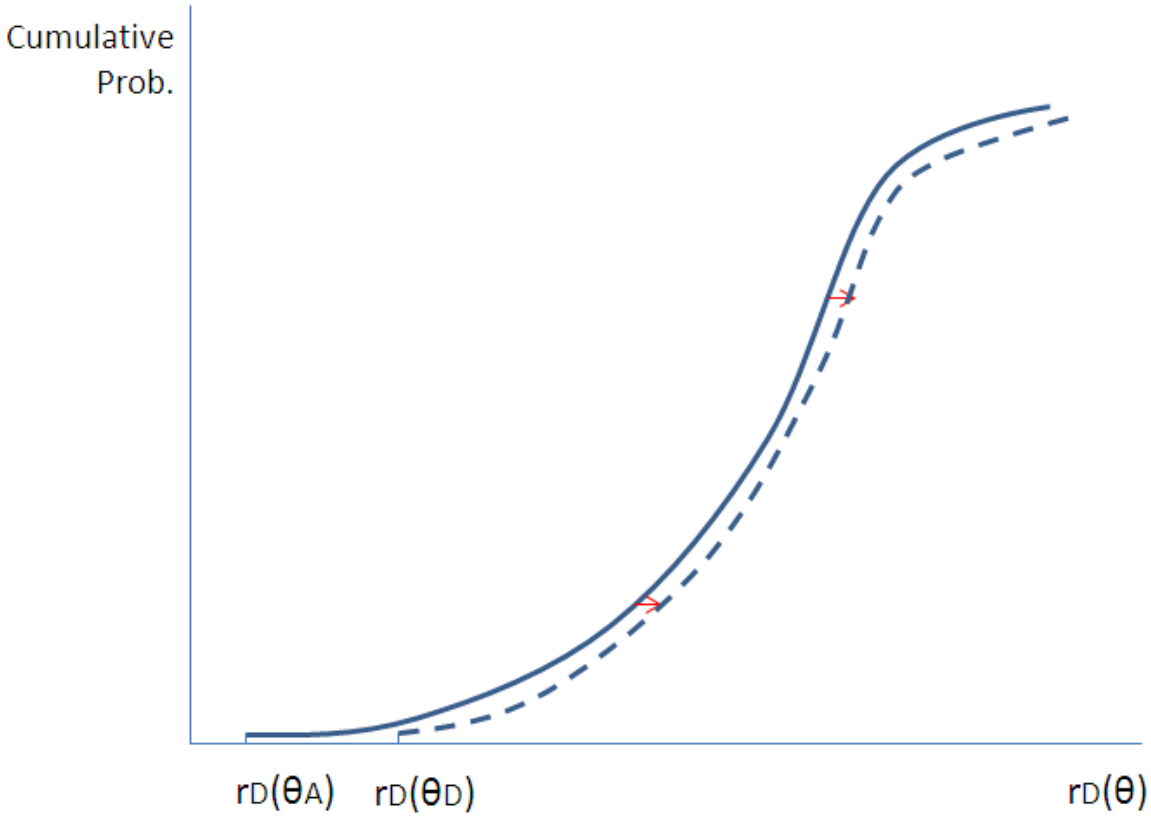

Figure 4: The revenue distribution before and after multinational entry

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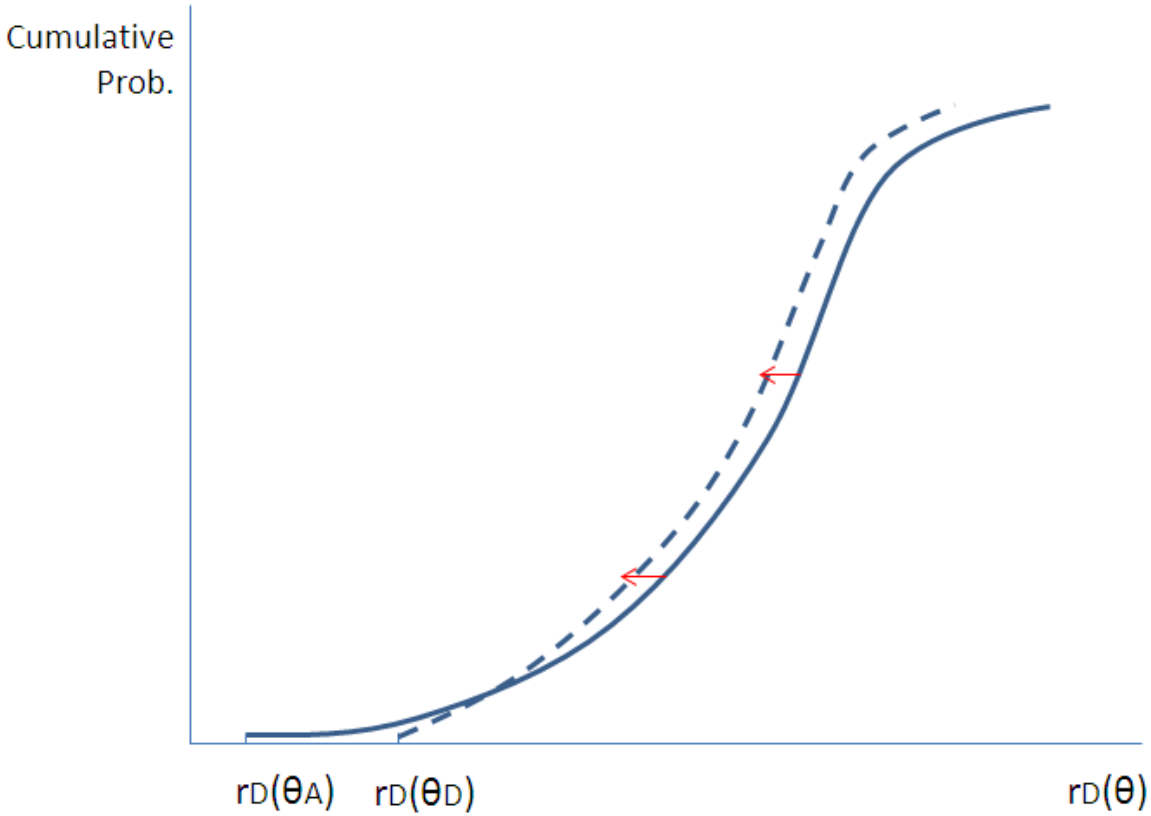

Figure 5: The revenue distribution before and after multinational entry

Model: Main Equations

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

$$\begin{aligned} & \Pr\left[z_M(\theta) = 1 | \theta > \theta_D\right] \\ = \quad & \Phi_{\theta > \theta_D}\left[\ln\theta + \ln\left(E^{\frac{1}{\varepsilon-1}}\alpha P/w\right) - \frac{1}{\varepsilon-1}\ln\left(\varepsilon cf_M\right) > 0\right]. \end{aligned}$$

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

$$\ln\theta_D-\ln\theta_A=\frac{1}{\varepsilon-1}\ln\frac{c}{c_A}+\ln\frac{P_A}{P}.$$

Model: Main Equations

- **Capital Market Reallocation**

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- **Labor Market Reallocation**

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

where q_A is the qth percentile in the ex-ante distribution.

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- **Knowledge Spillover**

$$\ln \theta(q_A) - \ln \theta_a(q_A) = \ln \tau_\theta.$$

Data

- We employ a cross-country firm-level panel dataset, drawn from Orbis, that contains comprehensive financial, operation, and ownership information for over 1 million manufacturing firms in 60 countries.

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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.

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  - Ownership information including domestic and global parents and domestic and foreign subsidiaries;
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  - 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 estimate total factor productivity using the semiparametric estimator developed by Olley and Pakes (1996).
  - The production function is estimated for each country and each NAICS 4-digit industry;
- 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

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

- FE_M: Country-industry fixed effects;

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- FE_M: Country-industry fixed effects;
- d: bilateral geographic factors
- θ: the **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

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The Selection of Multinational Firms

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- the expected productivity of multinational firms, i.e., $\widehat{\widetilde{\theta}}_M$.

Empirical Evidence

Table 1: The Self-Selection of Multinational Firms

Dependent var.: MNC entry	(1)	(2)
HQ TFP	0.004***	0.004***
	(0.001)	(0.001)
Distance	-0.003***	-0.007***
	(0.001)	(0.001)
Contiguity	0.06***	0.06***
	(0.004)	(0.007)
Language	0.03***	0.03***
	(0.003)	(0.004)
Host country-ind FE	Yes	Yes
HQ country-ind FE	No	Yes
Firm cluster	Yes	Yes
Obs	907,776	907,776
R square	0.08	0.08

Empirical Evidence

Multinational Activity and Average Productivity

Table 2: Multinational Activity and Average Productivity

Dependent var.:	(1)	(2)
Change in ---	Average TFP	Average TFP
MNC entry (predicted)	0.05*	0.02**
	(0.03)	(0.01)
Host country FE	-	Yes
Industry FE	-	Yes
Obs	60	2,814
R square	0.20	0.37

Empirical Evidence

The Selection of Domestic Firms: Survival

Table 3: The Survival of Domestic Firms

Dependent var.: Domestic firm survival	(1)	(2)
MNC entry (predicted)	-0.001***	-0.001***
	(0.000)	(0.000)
TFP (lagged)		0.002***
		(0.000)
Employment (lagged)		0.005***
		(0.000)
Country FE	Yes	Yes
Industry FE	Yes	Yes
Country-Industry cluster	Yes	Yes
Obs	548,249	548,249
R square	0.15	0.18

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

Dependent var.:	(1)	(2)
Change in ---	Cutoff TFP	Cutoff revenue
MNC entry (predicted)	0.16*	0.06***
	(0.09)	(0.03)
Host country FE	Yes	Yes
Industry FE	Yes	Yes
Obs	2,819	3,408
R square	0.38	0.43

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

$$\ln \theta(q_A) - \ln \theta_a(q_A) = (\ln \tau_\theta)\, z_M .$$

Empirical Evidence

Table 5: The Distributions of Domestic Firms

	(1) 25th Percentile	(2) 50th Percentile	(3) 75th Percentile
Panel A: TFP of different percentiles			
MNC entry (predicted)	0.03*	0.04***	-0.00
	(0.02)	(0.01)	(0.01)
Host country FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Obs	2,313	2,313	2,313
R square	0.14	0.15	0.13
Panel B: Revenue of different percentiles			
MNC entry (predicted)	-0.05***	-0.03*	-0.002
	(0.01)	(0.02)	(0.02)
Host country FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Obs	3,773	3,773	3,773
R square	0.19	0.17	0.12

Empirical Evidence

Table 6: Estimated Effects of Multinational Activity

Variables	Parameters
Cutoff productivity	0.16
Cutoff revenue/Financing cost	0.06
Aggregate real price	-0.10
Revenue -- 25th perc.	-0.05
Revenue -- 50th perc.	-0.03
Revenue -- 75th perc.	0.00
Knowledge spillovers -- 25th perc.	0.03
Knowledge spillovers -- 50th perc.	0.04
Knowledge spillovers -- 75th perc.	0.00

Quantifying Productivity Gains

Aggregate Productivity Gain:

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

where $\widehat{\widetilde{\theta}}_D$, $\widehat{\widetilde{\theta}}_M$, $\widehat{\gamma}_D$, and $\widehat{\gamma}_M$ are used to proxy for $\widetilde{\theta}_D$, $\widetilde{\theta}_M$, N_D/N_A, and γ_M, respectively.

Quantifying Productivity Gains

Decomposition: Aggregate productivity gain consists of:

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

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    1. Market reallocations: $\Delta\widetilde{\theta}_D\Big|_{\beta_\theta=0} = \frac{\widetilde{\theta}_D}{\widetilde{\theta}_A}\Big|_{\beta_\theta=0} - 1.$
    2. Knowledge spillovers: $\Delta\widetilde{\theta}_D\Big|_{\beta_P,\beta_c=0} = \frac{\widetilde{\theta}_D}{\widetilde{\theta}_A}\Big|_{\beta_P,\beta_c=0} - 1.$

Quantifying Productivity Gains

Table 7: Estimated TFP Gains

TFP Gains	Estimates		
(in percentage)	All	Developed	Developing
Aggregate	1.40	1.22	2.11
Multinational Firms	4.90	7.29	1.31
Domestic Firms	0.87	0.55	2.25
-- Spillover	0.60	0.20	2.20
-- Reallocation	0.27	0.35	0.05

Additional Analysis

- 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

Summary

- 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

Aggregate		Multinational		Domestic		Spillover		Reallocation	
Lithuania	21.22	Hong Kong	74.73	Lithuania	22.28	Lithuania	22.01	Canada	0.90
Norway	8.06	France	67.38	Norway	9.91	Norway	9.79	Sweden	0.52
France	5.62	Austria	34.74	Bulgaria	6.57	Bulgaria	6.28	Ireland	0.42
Argentina	5.52	Mexico	30.93	Argentina	5.97	Argentina	5.73	Russia	0.40
Bulgaria	5.50	Spain	23.84	Sweden	4.75	Sweden	4.23	Austria	0.38
Sweden	4.99	Ukraine	23.58	Finland	3.00	Finland	2.63	Romania	0.37
Hong Kong	3.67	Sweden	23.44	Czech Rep.	2.77	Czech Rep.	2.47	Finland	0.37
Finland	2.90	Portugal	23.06	Japan	1.13	Japan	0.82	Belgium	0.36
Spain	1.93	Japan	22.63	Spain	0.95	Spain	0.60	Denmark	0.36
Japan	1.68	South Korea	20.43	Canada	0.90	France	0.42	France	0.36

Cross-Country Heterogeneity

Table 9: Estimated TFP Gains and FDI Promotion Policies

	Aggregate	Multinational	Domestic	Spillover	Reallocatic
Incentives	0.001	-0.23**	0.01	0.01	-0.001*
	(0.01)	(0.11)	(0.01)	(0.01)	(0.00)
Financial incentives	0.01	0.08	0.01	0.001	-0.001*
	(0.02)	(0.12)	(0.02)	(0.01)	(0.00)
Tax holiday	0.03	-0.35***	0.04*	0.04*	-0.001*
	(0.03)	(0.11)	(0.02)	(0.02)	(0.00)
Tax reduction	-0.003	-0.22*	-0.001	0.01	-0.000
	(0.01)	(0.12)	(0.01)	(0.01)	(0.00)
Regulation exemption	-0.02**	-0.17*	-0.01	-0.001	-0.001*
	(0.01)	(0.10)	(0.01)	(0.004)	(0.00)
Number of incentives	-0.004	-0.06**	-0.001	-0.000	-0.0002*
	(0.01)	(0.03)	(0.01)	(0.004)	(0.00)

Within- and Between-Industry Reallocations

Table 10: Within- and Between-Industry Reallocations

Dependent var.:	(1)	(2)	(3)	(4)
Change in ---	Cutoff TFP		Cutoff Revenue	
MNC entry (predicted)				
in the same industry	0.09***	0.15***	0.07***	0.05***
	(0.04)	(0.04)	(0.03)	(0.02)
in related industries				
-- Labor similarity	0.02***		-0.002	
	(0.003)		(0.002)	
-- Capital similarity		0.004		0.005***
		(0.003)		(0.001)
Host country FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Obs	2,802	2,802	3,391	3,391
R square	0.37	0.36	0.33	0.33

Within- and Between-Industry Knowledge Spillovers

Table 11: Within- and Between-Industry Knowledge Spillovers (Developed Countries)

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