The organization of knowledge in multinational firms

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Motivation

Knowledge increasingly important production factor, but **spatial diffusion limited**

MNEs' foreign production **major channel of knowledge diffusion** (Keller, 2004)

However, spatial and cultural frictions hamper flow of information within MNEs (e.g. Ambos & Ambos, 2009; UNCTAD, 2004, ch. IV A.2)

$\Leftrightarrow$ Most models of MNEs assume **perfect diffusion** of knowledge within firm (e.g. Markusen, 1984; Helpman et al., 2004; Keller & Yeaple, 2013)

Research question:
How do spatial communication frictions within MNEs affect their organization of knowledge, the geography of their investments and their wage setting behavior?

Overview (I)

Assumptions

- ▷ Firm = headquarters + domestic (and foreign) production affiliate(s)
- ▷ Production based on labor and knowledge
- ▷ Knowledge firm-specific and non-rival within firm

- ▷ Employees have to **learn** knowledge for knowledge to be useful in production
- ▷ **Communication** among employees possible

- ▷ Learning remunerated
- ▷ Communication time-consuming; more time if communication across border

Overview (II)

Firm task: **efficiently organize** learning of **knowledge** $\rightarrow$ **trade-off**

- $\triangleright$ Higher fraction of knowledge at headquarters $\rightarrow$ more costly communication
- $\triangleright$ Higher fraction of knowledge at affiliates $\rightarrow$ higher learning expenses

$\Rightarrow$ MNE: **Heterogeneous** optimal local production worker knowledge levels

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⇒ MNE: **Heterogeneous** optimal local production worker knowledge levels

Implications consistent with distinct features of MNE behavior:

- ▷ Marginal costs function of workers' knowledge → **Variation in sales/entry**
- ▷ Reorganization of knowledge in MNEs → Residual **MNE wage premiums**

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Supported by empirical evidence on German multinational firms

Literature & Contribution

Gravity due to headquarter inputs in foreign production (e.g. Bahar, 2013; Irarrazabal et al., 2013; Keller & Yeaple, 2013; Yeaple, 2013)

→ *Here:* Headquarters **choice variable** of MNE

⇒ Endogenous, non-constant, interdependent marginal costs of production

⇒ Gravity *and* (residual) MNE wage premiums

Wage premiums due to scale (e.g. Helpman et al., 2010; Caliendo & Rossi-Hansberg, 2012) or worker preferences (Egger & Kreickemeyer, 2013)

→ *Here:* Common headquarters = **organizational constraint**

⇒ MNE specific source of residual MNE wage premiums

Building blocks: firms as communication networks and knowledge hierarchies (e.g. Bolton & Dewatripont, 1994; Garicano, 2000; Garicano & Rossi-Hansberg, 2006; Antràs et al., 2006; Caliendo & Rossi-Hansberg, 2012; Caliendo et al., 2013)

Outline

1. Theory
   - Cost-minimization
   - Profit maximization
   - General equilibrium
   - MNE wage premiums
2. Empirical strategy & Data
3. Empirical specification & Regression results

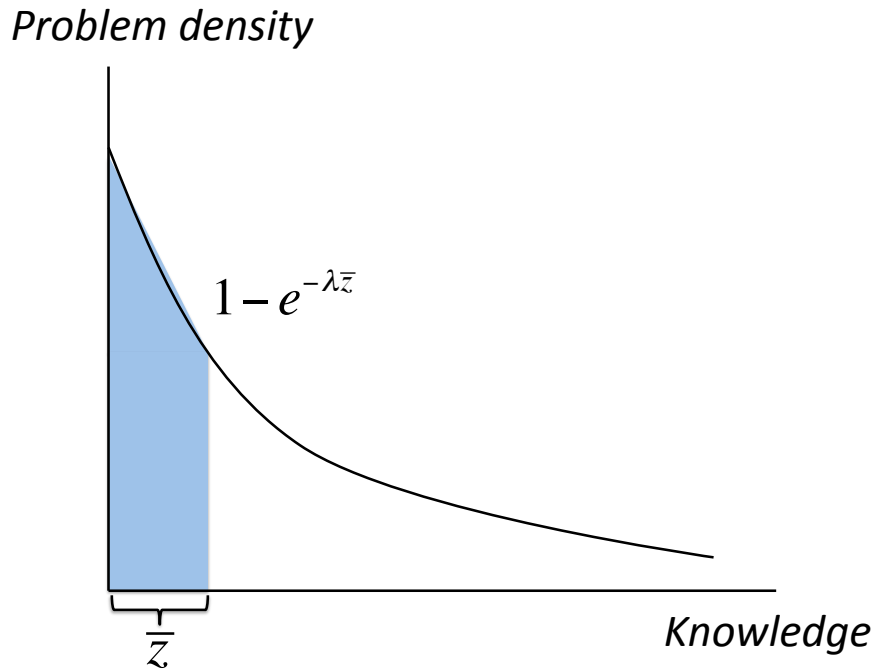
Set-up (I)

Two countries, $j = 0$ (home) and $j = 1$ (foreign)
N_j agents per country, each endowed with one unit of time
∞ potential firms per country, each producing a differentiated final product

Production $\equiv$ **problem solving process** based on labor and knowledge (Garicano, 2000)

1 unit of labor
$\downarrow$
Mass 1 of problems
from distribution function $\lambda e^{-\lambda z}$
$\downarrow$
Output if problem solved,
Output $q_j = 1 - e^{-\lambda \bar{z}}$

λ: problem arrival rate



Set-up (II)

- ▷ Firm characterized by **firm-specific knowledge level** $[0, \bar{Z}]$ of length $\bar{z}$
- ▷ Employees have to **learn knowledge** for its being useful in production
- ▷ Employees can **communicate problems** $\rightarrow$ leverage differences in knowledge

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- ▷ **Firm** $= n_h$ headquarter managers with knowledge z_h, n_j domestic (foreign) production workers with knowledge z_j (n_x, z_x, $x = h, j$ endogenous)
- ▷ Both **learning and communication costly**:
  learning: increased remuneration $w_j(1 + c_j z_x)$, $x = j, h$,
  communication: $\theta_{kj} < 1$ units of time (to receive message from k in j)

  Cross-border communication more costly than within country communication
  $1 > \theta_{10} \geq \theta_{00} > 0$, $\theta_{10} = \theta_{01}, \theta_{00} = \theta_{11}$

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  Cross-border communication more costly than within country communication
  $1 > \theta_{10} \geq \theta_{00} > 0$, $\theta_{10} = \theta_{01}, \theta_{00} = \theta_{11}$
- ▷ Only workers input labor, managers only input knowledge (Garicano, 2000)

⇒ Workers' knowledge $[0, Z_j]$ of length z_j: more frequent problems
Managers' knowledge $[Z_h, \bar{Z}]$ of length z_h: infrequent problems

Optimal to learn full knowledge interval, so $z_h + z_j \geq \bar{z} \, \forall j$

Cost minimization problem

Optimization problem:
Choose number of employees at production affiliate(s) and headquarters as well as their knowledge levels such that overall costs of production minimized

$$C(\bar{z}, q_0, w_0, q_1, w_1) = \min_{\{n_j, z_j\}_{j=0}^{1}, n_h, z_h} \sum_{j=0}^{1} n_j w_j (1 + c_j z_j) + n_h w_0 (1 + c_0 z_h)$$

$$\text{s.t.} \quad n_j (1 - e^{-\lambda \bar{z}}) \geq q_j \quad \forall j$$

$$n_h \geq \sum_{j=0}^{1} \theta_{j0} n_j e^{-\lambda z_j}$$

$$z_j + z_h \geq \bar{z} \quad \forall j$$

$$n_h \geq 0,\ z_h \geq 0, z_h \leq \bar{z}$$

$$n_j \geq 0,\ z_j \geq 0, z_j \leq \bar{z} \quad \forall j$$

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$$n_h \geq 0,\ z_h \geq 0, z_h \leq \bar{z}$$

$$n_j \geq 0,\ z_j \geq 0, z_j \leq \bar{z} \quad \forall j$$

$\rightarrow$ n_j, n_h determined by constraints

$\rightarrow$ $z_j + z_h \geq \bar{z}$ binding for (at least) one country

Organization of knowledge

Domestic firm/exporter

Knowledge level of managers

$$\underbrace{n_0 w_0 c_0}_{\text{Marg. benefit of increasing } z_h \text{ Decrease in workers' learning}} = \underbrace{n_0 \theta_{00} e^{-\lambda(\bar{z}-z_h)} w_0 (c_0 + \lambda(1 + c_0 z_h))}_{\text{Marg. costs of increasing } z_h \text{ Increase in learning + change in \# of managers}}$$

$\rightarrow$ Knowledge determined by θ_{00}, c_0, λ, $\bar{z}$ ($\theta_{10}, c_j, \lambda, \bar{z}, w_j$ for vertical MNEs)

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$\rightarrow$ Knowledge determined by θ_{00}, c_0, λ, $\bar{z}$ ($\theta_{10}, c_j, \lambda, \bar{z}, w_j$ for vertical MNEs)

(Horizontal) Multinational firm

Knowledge level of managers ($z_0 = \bar{z} - z_h$, $z_1 > \bar{z} - z_h$)

$$\underbrace{n_0 w_0 c_0}_{\substack{\text{MB of increasing } z_h \\ \text{Decrease in workers' learning}}} = \underbrace{n_1 \theta_{10} e^{-\lambda z_1} w_0 c_0 + n_0 \theta_{00} e^{-\lambda(\bar{z}-z_h)} w_0 (c_0 + \lambda(1 + c_0 z_h))}_{\substack{\text{MC of increasing } z_h \\ \text{Increase in learning + change in \# of managers}}}$$

$\rightarrow$ Additional determinants: q_j via n_j, w_j via z_1, $j = 0, 1$

$\Rightarrow$ z_h chosen by MNE different from domestic optimum

Organization of knowledge: Results

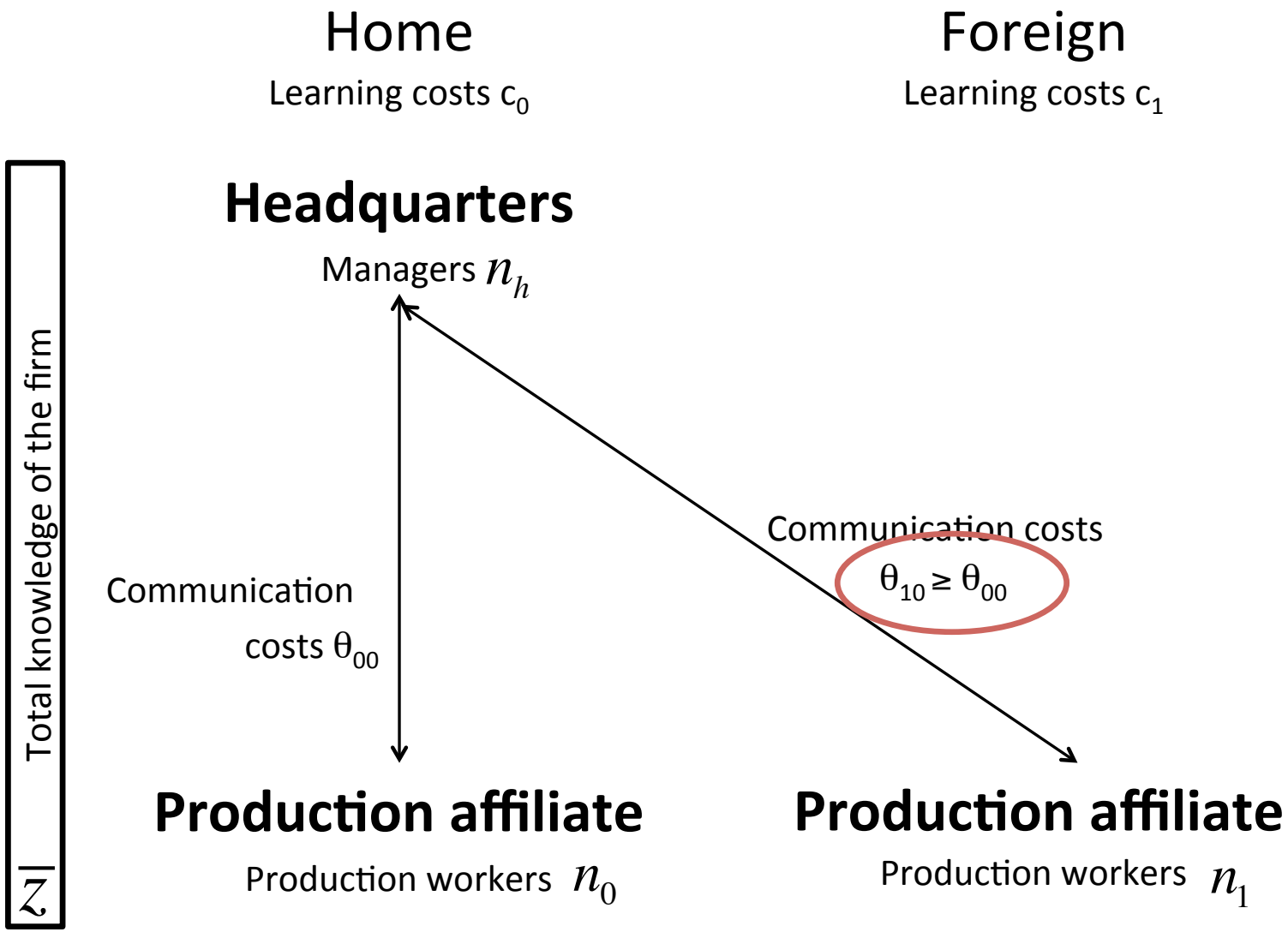
Domestic firm/exporter

Knowledge level of production workers z_0

- $-$ learning costs c_0
- $+$ communication costs θ_{00}
- $+$ total firm knowledge $\bar{z}$

Constant marginal costs of production

Organization of knowledge: Illustration



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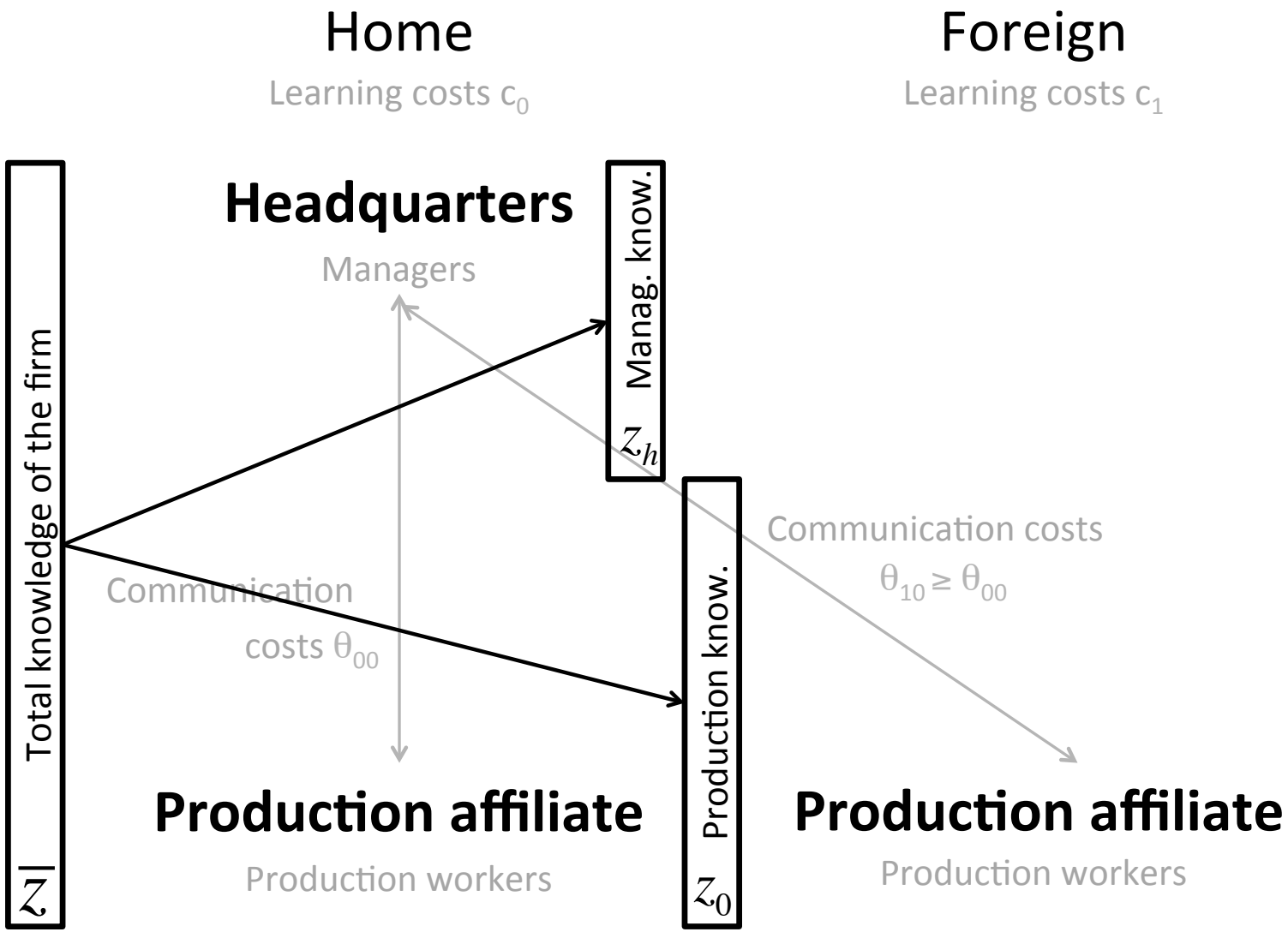

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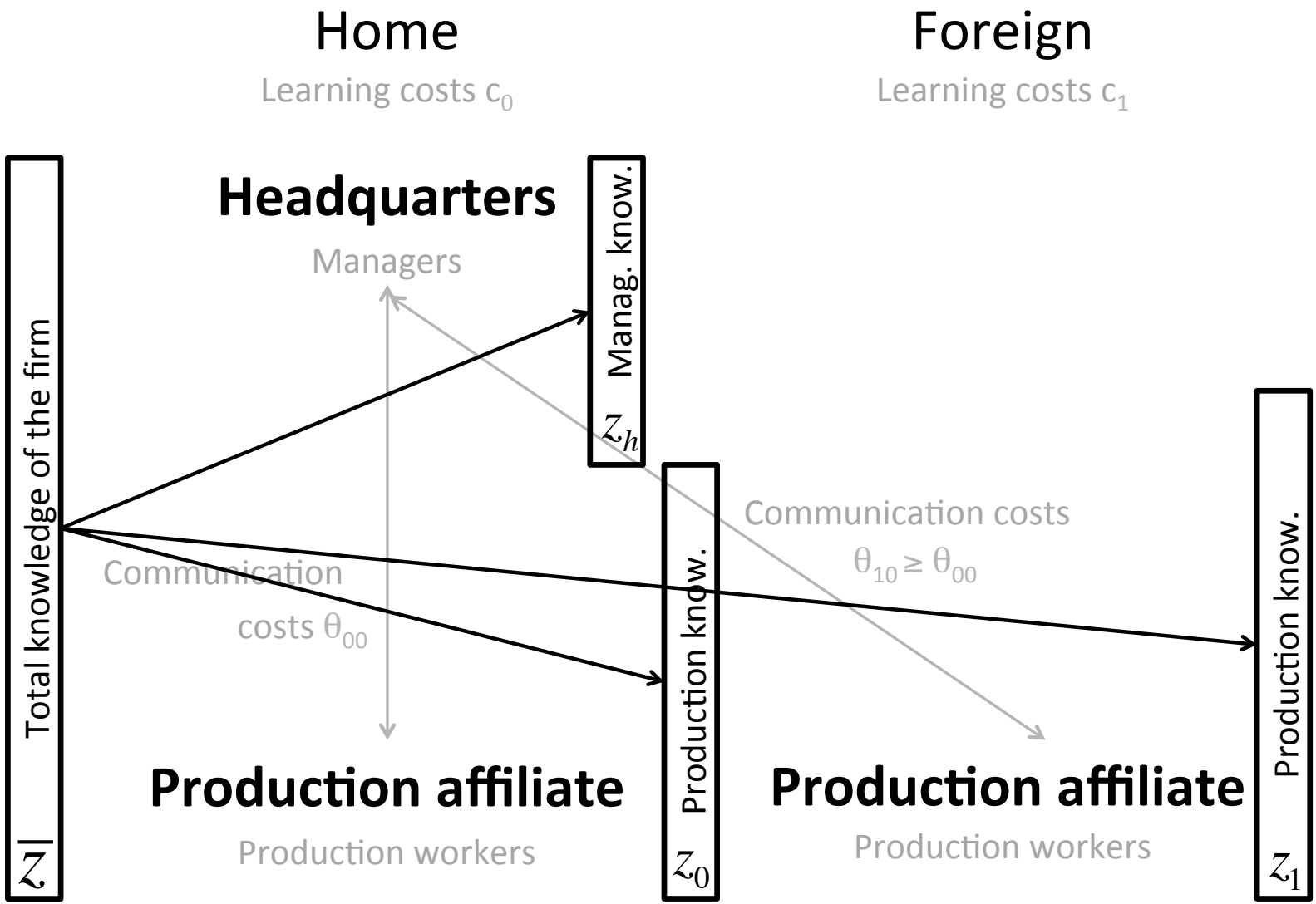

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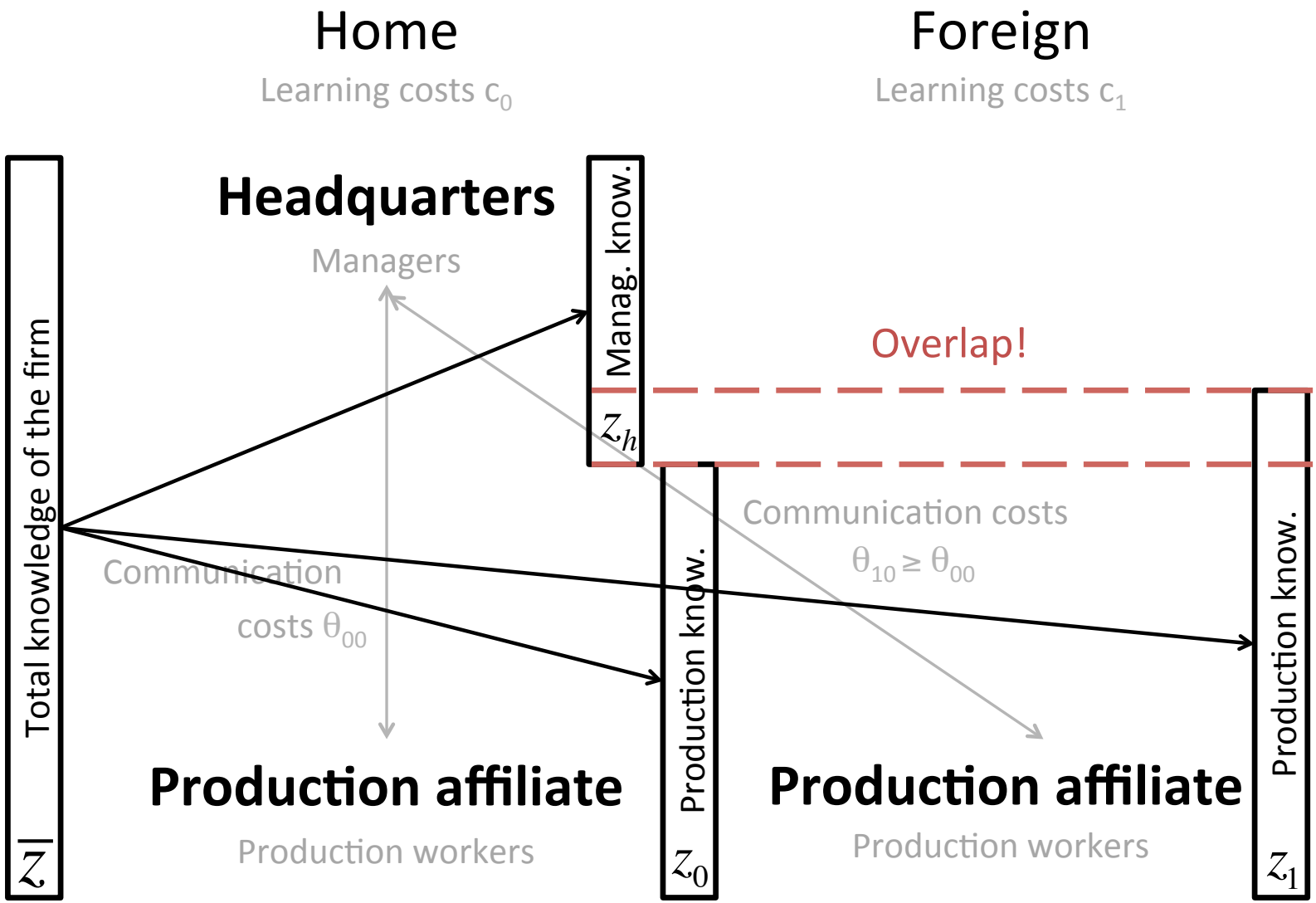

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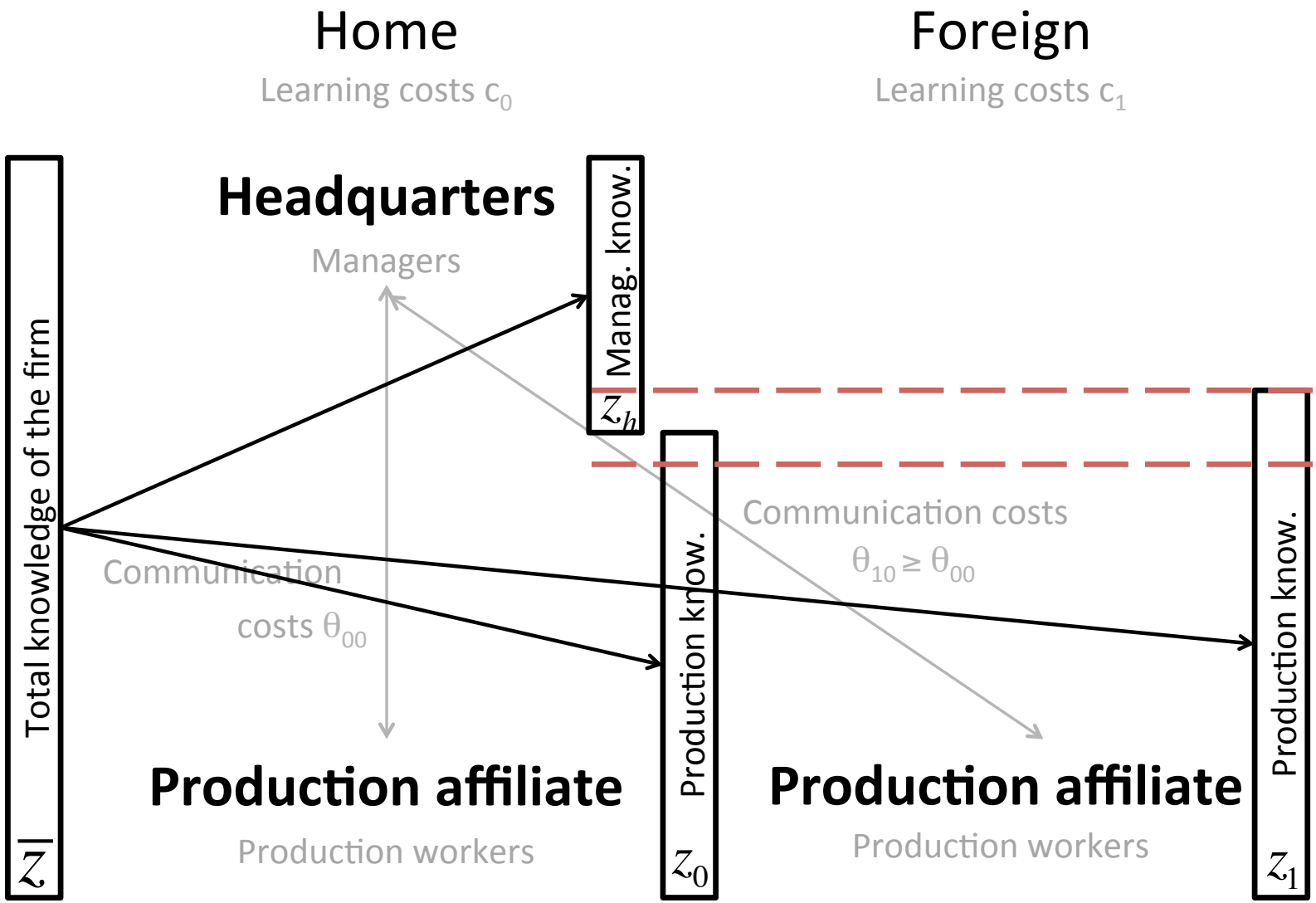

Organization of knowledge: Results

Horizontal multinational firm

Knowledge level of production workers z_j

– learning costs c_j

\+ communication costs θ_{j0}

(+) total firm knowledge $\bar{z}$

– production quantity q_j

\+ production quantity $q_k, k \neq j$

Non-constant marginal costs of production

Organization of knowledge: Implications

Variation in marginal costs of production across countries

$$\xi_j = \frac{1}{1 - e^{-\lambda \bar{z}}} \left(w_j(1 + c_j z_j) + w_0(1 + c_0 z_h)\theta_{j0} e^{-\lambda z_j} \right)$$

- $+$ communication costs with headquarter θ_{j0}
- $-$ total firm knowledge $\bar{z}$
- $-$ production quantity q_j (only for horizontal MNEs)
- $+$ production quantity $q_k, k \neq j$ (only for horizontal MNEs)

$\rightarrow$ MNEs and domestic producers with same marginal costs may coexist

Variation in remuneration of workers across countries

Profit maximization

Many firms, firm i characterized by firm-specific knowledge level $\bar{z}_i$
Consumers with **CES preferences** in both countries

Iceberg transport costs τ
Fixed costs: domestic activity f^D, exporting f^X, FDI f^I with $f^I > \tau^{\sigma-1} f^X > f^D$

Firms choose profit-maximizing option among four alternatives:

1. Domestic firm
2. Exporter
3. Vertical MNE (serves both countries from foreign affiliate)
4. Horizontal MNE (serves each country from local affiliate)

Profit maximization: Results

Comparative statics

Foreign MNE production quantities and sales **decreasing** in communication costs

Profit maximization: Results

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Special features of **horizontal MNEs**:

$$q_j^I(\bar{z}_i) = Q_j P_j^{\sigma-1} \left(\frac{\sigma}{\sigma-1} \xi_j(\bar{z}_i, q_0^I(\bar{z}_i), w_0, q_1^I(\bar{z}_i), w_1) \right)^{-\sigma}$$

- ▷ Production quantities implicitly defined
- ▷ Effect via quantity **reinforces** direct effect of parameters:
  Example: $\theta_{10} \uparrow \quad \rightarrow \xi_1 \uparrow \quad \rightarrow q_1 \downarrow \quad \rightarrow \xi_1 \uparrow \quad \rightarrow q_1 \downarrow$
- ▷ Domestic performance affected by FDI:

$$q_0^D(\bar{z}_i) = q_0^X(\bar{z}_i) \geq q_0^I(\bar{z}_i)$$

- ▷ Decision to become multinational depends on **total profits**:

$$\pi^I(\bar{z}_i, w_0, w_1) - w_0 f^I \geq \pi^X(\bar{z}_i, w_0) - w_0 f^X$$

General equilibrium sorting pattern

Unlimited mass of potential entrants, sunk costs of entry f
Symmetry in $c_0 = c_1$, $N_0 = N_1$
Standard equilibrium conditions (ZCP, FE, labor/goods market, trade balance)

Zero cut-off profit conditions
Higher knowledge level $\bar{z}_i \rightarrow$ lower marginal costs $\rightarrow$ higher profits
$\rightarrow$ Cut-off knowledge levels $\bar{z}^*$, $\bar{z}^X$, $\bar{z}^I$ with $\bar{\mathbf{z}}^{\mathbf{I}} > \bar{\mathbf{z}}^{\mathbf{X}} > \bar{\mathbf{z}}^*$
$\rightarrow$ Cut-off marginal costs $\bar{\xi}^{\mathbf{I}} < \bar{\xi}^{\mathbf{X}} < \bar{\xi}^*$

Comparative statics

Probability of MNE entry **decreases** in communication costs:

- $\bar{z}^I$ increases in communication costs; decreases in transport costs;
  $\bar{\xi}^I$ decreases in communication costs; increases in transport costs

Multinational firm wage premiums

1. MNE wage premiums due to **selection**
   Production worker knowledge increasing in firm knowledge

$\Rightarrow$ MNE wage premiums due to selection of higher $\bar{z}$ firms into FDI

2. **Residual MNE wage premiums**
   i.e. MNEs pay higher wages than domestic firms with **same** marginal costs

   MNE wage premiums occur for sure
   - ▷ In home country if $\frac{w_1 c_1}{w_0 c_0} < \frac{\theta_{10}}{\theta_{00}}$
   - ▷ In foreign country if $\frac{w_1 c_1}{w_0 c_0} < \frac{\theta_{10}}{\theta_{00}}$ and $c_1 \geq c_0$ for horizontal MNEs, always for vertical MNEs

   MNE wage premiums vary with home/foreign country characteristics:
   Communication costs θ_{10}, relative wages w_1/w_0, relative learning costs c_1/c_0

$\Rightarrow$ MNE wage premiums for FDI from developed countries in particular to developing countries, consistent with empirical evidence (e.g. Aitken et al., 1996; Heyman et al., 2007; Hijzen et al., 2013; Girma & Görg, 2007)

Summary & Discussion

Communication frictions within MNEs affect optimal organization of knowledge in production

Impact consistent with major stylized facts of MNE behavior:

- ▷ Variation in sales
- ▷ Variation in entry probability
- ▷ Multinational firm wage premiums

Competing mechanism discussed in literature (e.g. Giroud, 2013) - **monitoring** - only explains investment features:

Higher cross-border monitoring costs

$\rightarrow$ Higher foreign wages, lower sales, lower investment probability

$\leftrightarrow$ Selection of firms with superior monitoring technology into FDI

$\Rightarrow$ Monitoring model predicts MNEs pay **lower** wages than other firms

Data

Required information for rigorous test of model:
Data on routineness of production tasks across different locations of MNEs (to my knowledge non-existant)

⇒ **Non-causal empirical analysis** based on
Microdatabase Direct investment, German central bank, 1999-2010

- ▷ Universe of German FDI at investor-affiliate-ownership channel level
- ▷ Restriction to majority owned affiliates
- ▷ Information on 164,608 observations at parent-country-year level

Target: document impact of **communication cost** beyond other factors

- ▷ Flight time Frankfurt-main city
- ▷ Linguistic distance
- ▷ Office hours overlap
- ▷ Telecommunication costs (monthly subscription to business telephone service)

Empirical hypotheses

1. Comparative statics on cut-off knowledge level $\bar{z}^I$/cut-off marginal costs $\bar{\xi}^I$: $\bar{\xi}^I$ decreasing in communication costs

$\Rightarrow$ **Hypothesis 1:** Observed cut-off productivity level of entrants increasing in communication costs

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2. Comparative statics on foreign marginal costs ξ_1:
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   ξ_1 decreasing in $\bar{z} \Rightarrow$ selection bias!

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$\Rightarrow$ **Hypothesis 2: within firm,** observed foreign productivity decreasing in communication costs

3. Can effects really be attributed to allocation of knowledge?
   Corollary: positive effect of communication costs on ξ_1 decreasing in problem arrival rate λ

$\Rightarrow$ **Hypothesis 3:** negative effect of communication costs on observed foreign productivity stronger for firms in sectors with higher R&D intensity

Caveats

1. **Coarse productivity measure**
   Lack of input data

   → Productivity measured as labor productivity $\ln\left(\frac{\text{sales}}{\text{employees}}\right)$

2. **Small number of sectors**
   Data distinguish 39 sectors at 2 digit NACE Rev. 1.1 level,
   R&D data available for only subset of 21 sector groups

3. **Non-causal interpretation**
   Largely non-causal interpretation appropriate due to self-selection of firms into destinations

Hypothesis 2: Within-firm variation in foreign productivity

Observed foreign productivity

- $-$ communication costs with headquarter
- $+$ firm-specific knowledge level

Specification: productivity differences

$$y_{ijt} = \beta_0 + \beta_1 \theta_{jt} + \beta_2 Q_{jt} + \beta_3 c_{jt} + \beta_4 w_{jt} + \gamma \mathbf{X}_{jt} + \alpha_{it} + \epsilon_{ijt}$$

with

- $\triangleright$ y_{ijt}: firm i's labor productivity ($\ln(\frac{\text{sales in j}}{\text{employees in j}})$) in country j in year t
- $\triangleright$ θ_{jt}: communication costs between Germany and country j in year t
- $\triangleright$ Q_{jt}, c_{jt}, w_{jt}, $\mathbf{X}_{jt}$: controls
- $\triangleright$ α_{it}: parent-year fixed effect
- $\triangleright$ ϵ_{ijt}: error term

No causal interpretation due to self-selection of firms into destinations

Hypothesis 2: Foreign productivity - Regression results (I)

Linguistic distance	-0.071^{**}	-0.064^{*}	-0.084^{***}	-0.066^{**}
	(0.030)	(0.034)	(0.032)	(0.030)
Log flight time	-0.044^{***}	-0.005	-0.028^{**}	-0.109^{***}
	(0.011)	(0.013)	(0.013)	(0.026)
Time difference to Germany	0.020^{***}	0.036^{***}	0.042^{***}	0.019^{***}
	(0.002)	(0.003)	(0.004)	(0.002)
Log GDP	0.057^{***}	0.081^{***}	0.098^{***}	0.052^{***}
	(0.008)	(0.011)	(0.011)	(0.008)
Public expenditure per pupil, % GDP p.c.	0.016^{***}	0.018^{***}	0.013^{***}	0.014^{***}
	(0.002)	(0.003)	(0.002)	(0.002)
GDP per employee	0.207^{***}	0.151^{***}	0.108^{***}	0.214^{***}
	(0.008)	(0.012)	(0.015)	(0.009)
Log compensation per employee		-0.013^{**}		
		(0.006)		
Trust, survey 1996			0.231^{***}	
			(0.032)	
Log distance				0.048^{***}
				(0.018)
Constant	4.374^{***}	4.327^{***}	3.943^{***}	4.390^{***}
	(0.094)	(0.110)	(0.112)	(0.093)
R^2	0.191	0.136	0.138	0.191
Observations	116,702	91,600	99,061	116,702
# country combinations	9,037	8,628	8,638	9,037
# countries	87	21	23	87

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Parent-year fixed effects.

Hypothesis 2: Foreign productivity - Regression results (II)

Linguistic distance	0.001			
	(0.031)			
Log flight time		−0.146***		
		(0.028)		
Office hours overlap			0.012**	
			(0.005)	
Log monthly subscription phone				−0.047***
				(0.014)
Log GDP	0.034***	0.031***	0.016**	0.022***
	(0.008)	(0.008)	(0.008)	(0.008)
Public expenditure per pupil, % GDP p.c.	0.019***	0.013***	−0.002	−0.001
	(0.002)	(0.002)	(0.002)	(0.002)
GDP per employee	0.216***	0.229***	0.056***	0.043***
	(0.009)	(0.009)	(0.011)	(0.012)
Log GDP per capita			0.409***	0.431***
			(0.019)	(0.021)
Log trade costs	−0.134***	−0.137***	−0.063***	−0.060**
	(0.025)	(0.024)	(0.024)	(0.024)
Log distance	0.039***	0.135***	0.067***	0.046***
	(0.011)	(0.021)	(0.014)	(0.010)
Constant	4.361***	4.513***	0.949***	1.079***
	(0.102)	(0.106)	(0.221)	(0.201)
R^2	0.194	0.196	0.223	0.224
Observations	99,177	99,177	99,177	99,177
# country combinations	8,843	8,843	8,843	8,843

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Parent-year fixed effects.

Hypothesis 3: Effect of communication costs across sectors

Negative effect of communication costs on foreign productivity

\+ problem arrival rate
i.e. mitigated by lower R&D intensity/ reinforced by higher R&D intensity

Specification: productivity differences

$$y_{ijt} = \beta_0 + \beta_1 \theta_{jt} \times \lambda_{it} + \beta_2 y_{i0t} + \beta_3 Q_{jt} + \beta_4 c_{jt} + \beta_5 w_{jt} + \gamma \mathbf{X}_{jt} + \alpha_s + \alpha_j + \alpha_t + \epsilon_{ijt}$$

with

- y_{ijt}: firm i's labor productivity (ln(sales/employees)) in country j in year t
- $\theta_{jt} \times \lambda_{it}$: interaction of communication costs between Germany and country j in year t and R&D intensity of sector of firm i in year t
- y_{i0t}: firm i's domestic labor productivity in year t
- Q_{jt}, c_{jt}, w_{jt}, $\mathbf{X}_{jt}$: controls
- α_s, α_j, α_t: sector, country and year fixed effects
- ϵ_{ijt}: error term

Only MNEs that are active in multiple countries

Hypothesis 3: Effect of communication costs across sectors

Dependent variable: foreign productivity				
Int. R&D intensity × log flight time	-0.006^{**}			-0.005^{*}
	(0.003)			(0.003)
Int. R&D intensity × linguistic dist.		-0.031^{**}		-0.010
		(0.018)		(0.017)
Int. R&D intensity × time zone difference			0.004^{***}	0.004^{***}
			(0.001)	(0.001)
Domestic productivity	0.203^{***}	0.203^{***}	0.205^{***}	0.202^{***}
	(0.025)	(0.025)	(0.025)	(0.025)
R^2	0.290	0.290	0.290	0.291
Observations	36,329	36,316	36,329	36,316

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Country, sector and time dummies included.

Controls: GDP, Public expenditure per pupil, % GDP p.c., GDP per employee.

Robustness checks

- ▷ Extensive margin results robust to different cut-off levels (5th/10th percentile)
- ▷ Intensive margin results robust to Heckman selection model, exclusion of affiliate sector groups (e.g. wholesale/retail trade)
- ▷ Robust to additional FDI/productivity determinants:
  - taxation,
  - institutional quality
- ▷ Robust to using alternative measures of model parameters

Conclusion

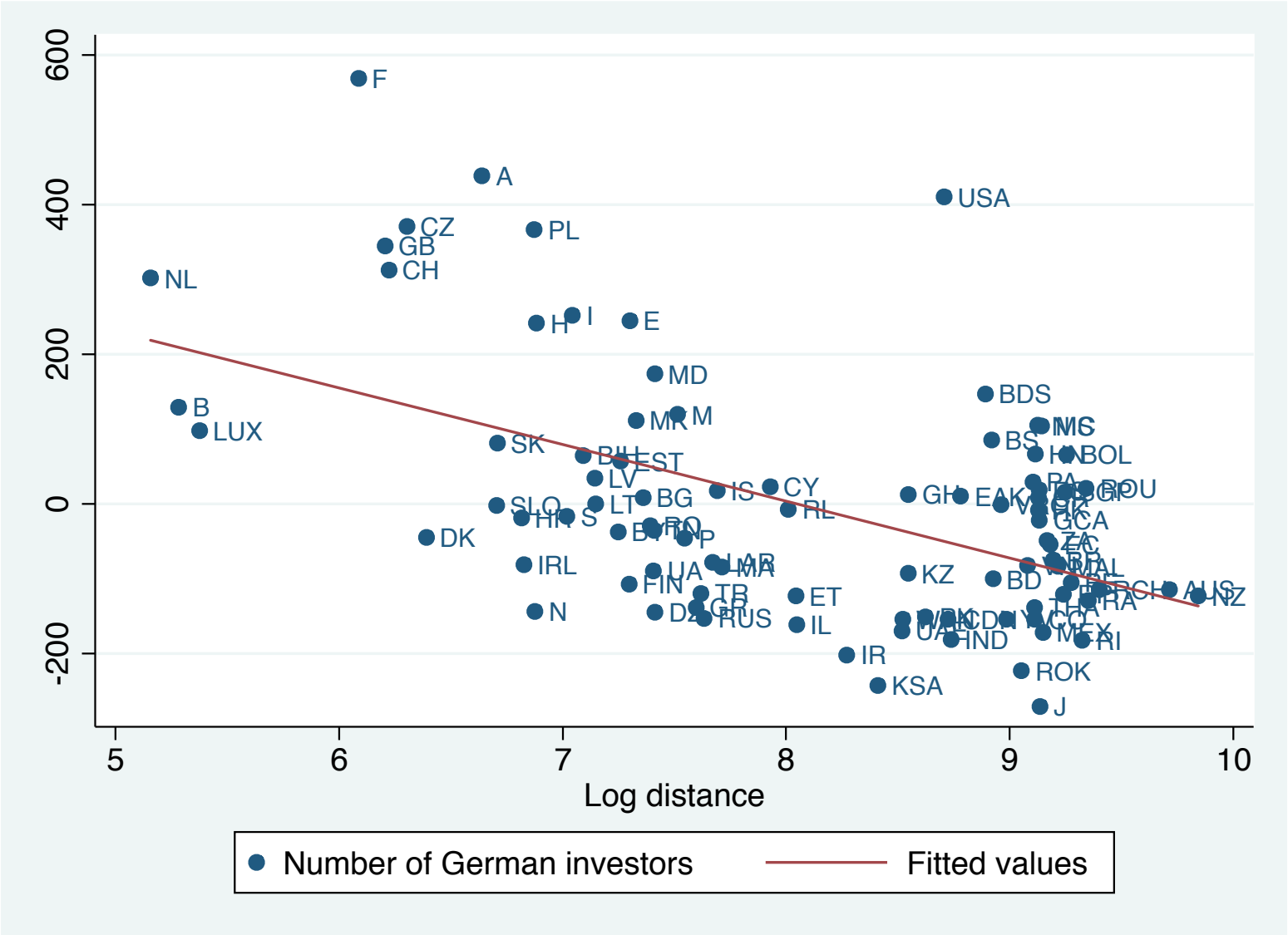
Spatial communication frictions within multinational firms

- ▷ increase the knowledge of production workers at home and abroad,
- ▷ decrease foreign sales and the entry probability,
- ▷ and explain why residual MNE wage premiums arise.

Empirics:

- ▷ Predicted investment and wage setting behavior consistent with stylized facts
- ▷ In line with within-parent across-country labor productivity differences

The geography of MNE entry



Residual number of entrants from regression of number of entrants on GDP.

Source: MiDi data base.

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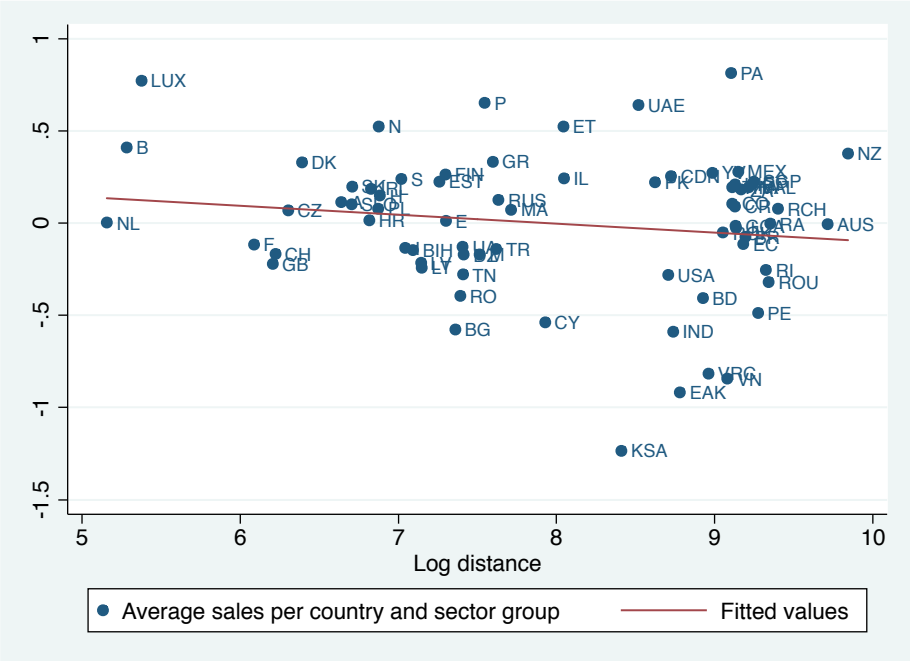
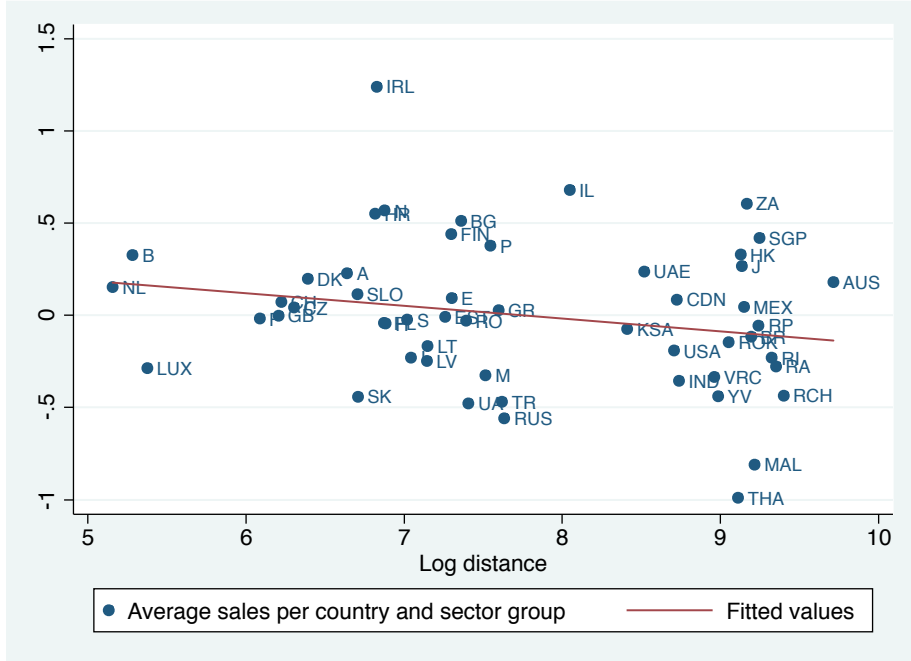
The geography of MNE sales





Residual average sales from regression of average sales per country on GDP.

Source: MiDi data base, 2005.

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Hypothesis 1: Cut-off productivity levels

Cut-off productivity levels

+ communication costs with headquarter

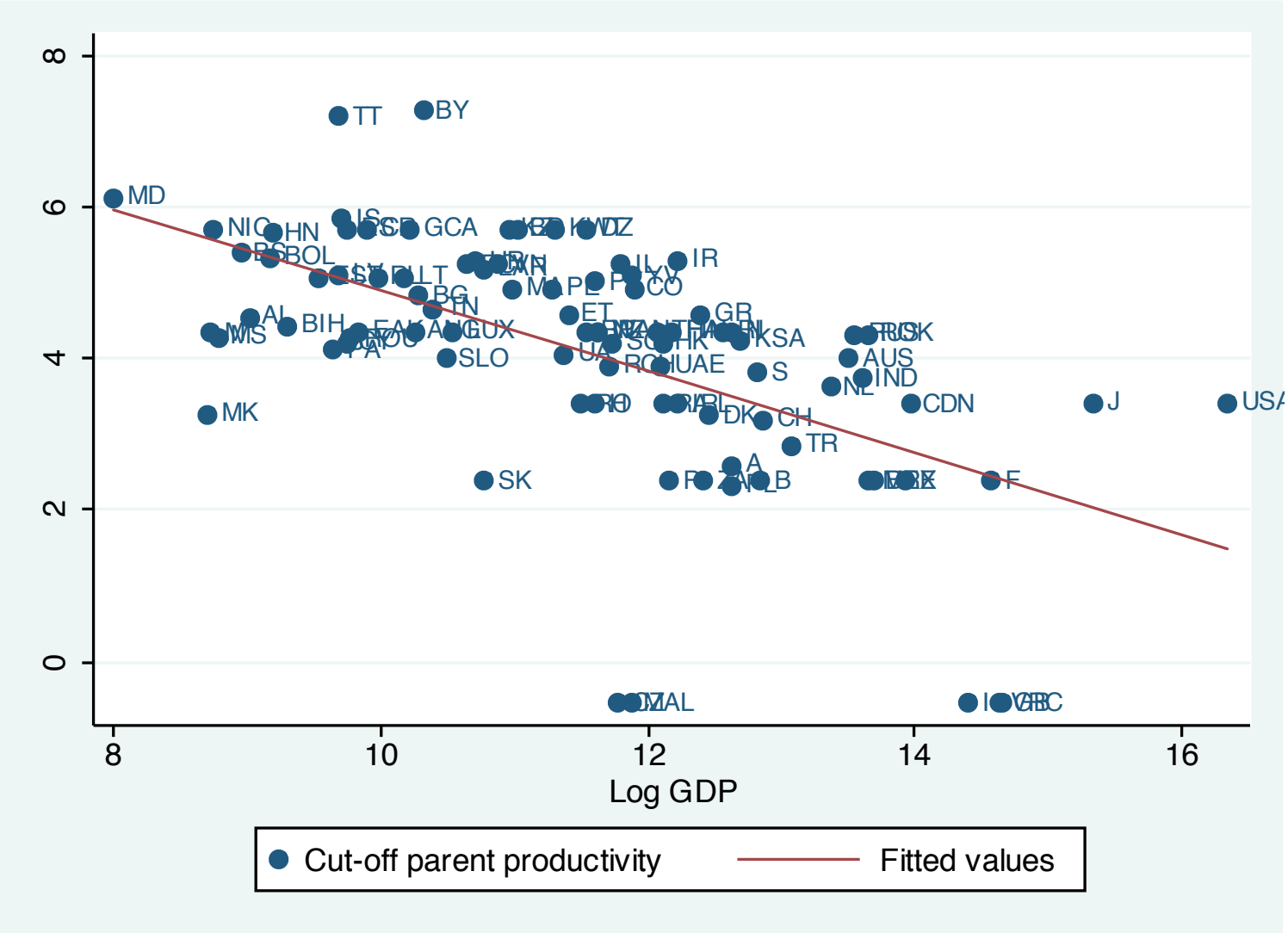
Specification

$$y_{sjt} = \beta_0 + \beta_1 \theta_{jt} + \beta_2 c_{jt} + \beta_3 Q_{jt} + \beta_4 w_{jt} + \beta_5 A_{jt} + \alpha_t + \alpha_s + \epsilon_{sjt}$$

with

- y_{sjt}: minimum domestic productivity $\ln(\frac{\text{domestic sales}}{\text{domestic employees}})$ of investors in sector s that invest in country j in year t
- θ_{jt}: communication costs between Germany and country j in year t
- c_{jt}, Q_{jt}, w_{jt}, A_{jt}: controls (learning costs, market size, wages, labor productivity of j in t)
- α_s, α_t: sector, year fixed effect
- ϵ_{sjt}: error term

Cut-off productivity and market size



Source: MiDi data base.

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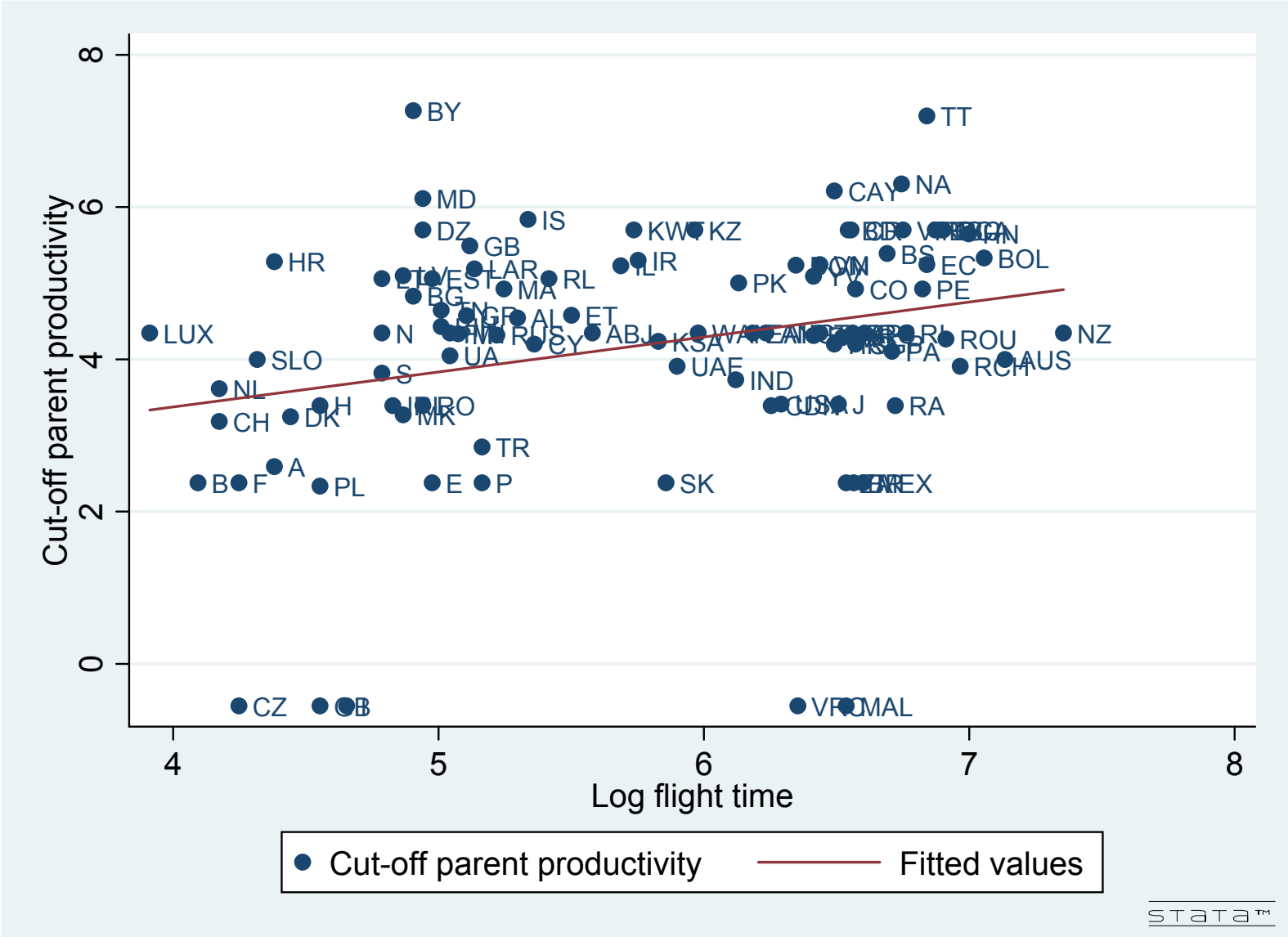
Hypothesis 1: Cut-off productivity - Graphical evidence



▸ GDP

Source: MiDi data base, 2005. Minimum domestic productivity of investors per country.

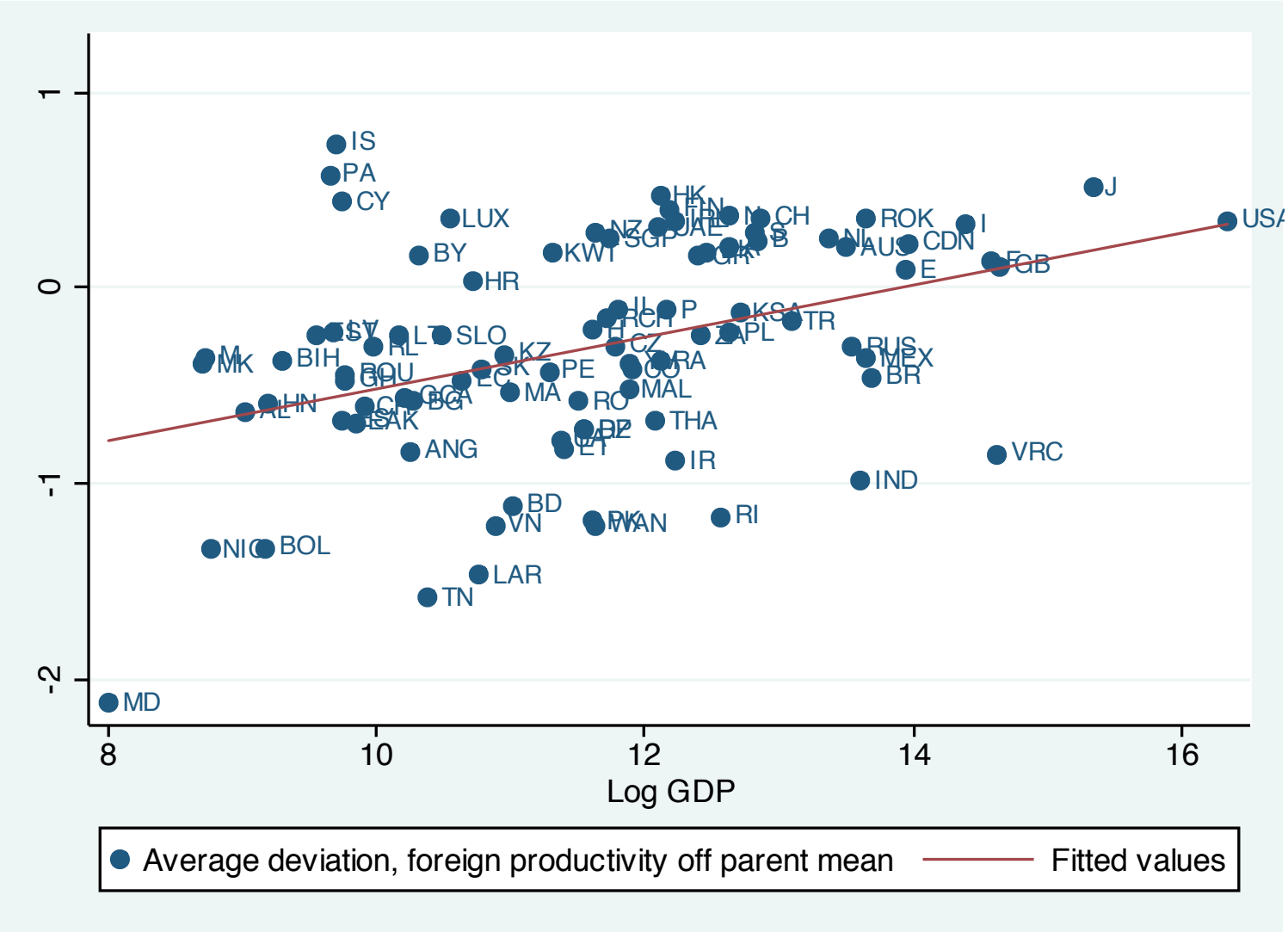
Hypothesis 1: Cut-off productivity - Regression results

Log flight time	0.212^{***}	0.321^{***}	0.366^{***}
	(0.057)	(0.058)	(0.120)
Linguistic distance	0.407^{***}	0.404^{***}	0.516^{***}
	(0.096)	(0.092)	(0.092)
Difference time zone	0.009	0.005	-0.003
	(0.009)	(0.012)	(0.009)
Per pupil public exp. on educ., % GDP p.c.	0.007	0.031^{**}	0.023
	(0.011)	(0.014)	(0.011)
Log GDP	-0.157^{***}	-0.168^{***}	-0.146^{***}
	(0.028)	(0.058)	(0.044)
GDP per employee	-0.000	0.048	0.065
	(0.036)	(0.056)	(0.052)
Log compensation per employee		0.027	0.018
		(0.025)	(0.013)
Cost of starting a business			0.090^{***}
			(0.021)
Log distance			-0.025
			(0.083)
Constant	5.285^{***}	3.800^{***}	2.999^{***}
	(0.504)	(0.548)	(0.419)
R^2	0.326	0.394	0.400
Observations	8,154	4,708	4,708

Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Year and sector dummies included.

Foreign performance and market size



Note: deviations in foreign prod. off parent mean (i.e. controlling for heterogeneity).

Source: MiDi data base, 2005.

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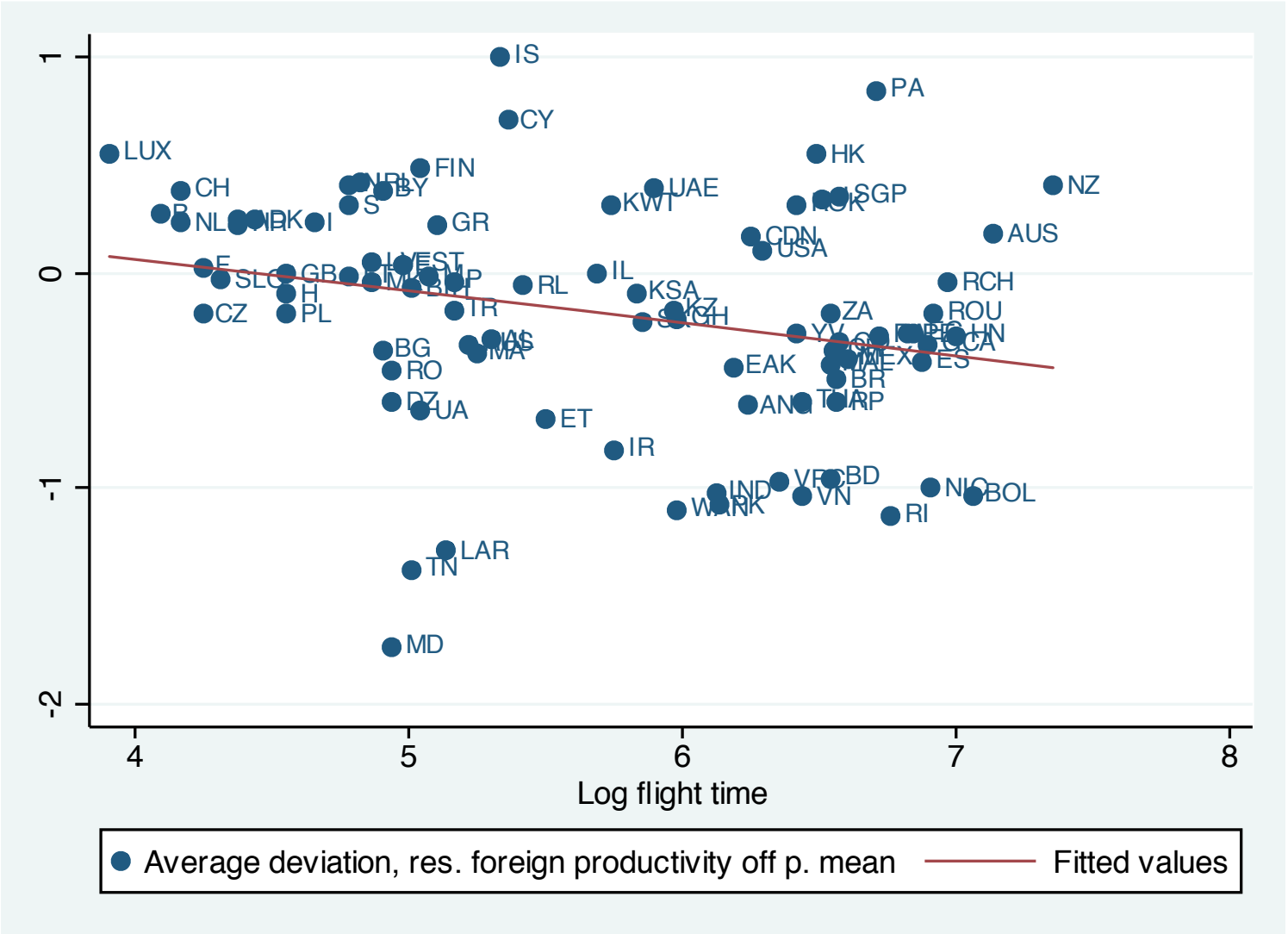
Hypothesis 2: Foreign productivity - Graphical evidence

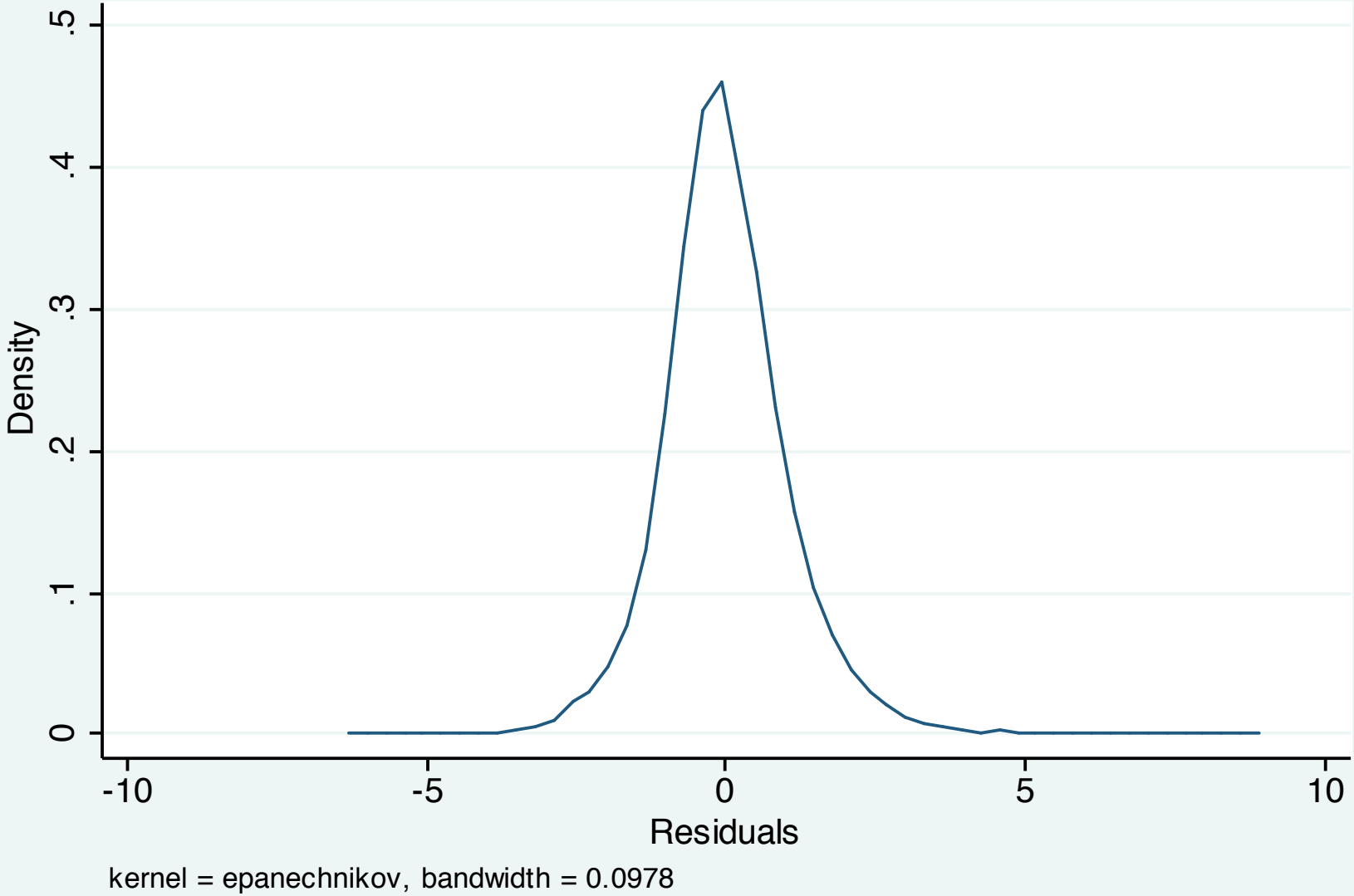


Note: dev. in residual for. prod. off parent mean (i.e. control. for GDP & heterog.).

Source: MiDi data base, 2005.

▸ GDP

Heckman selection model: foreign productivity



Heckman selection model: investment probability