

# Export Versus FDI with Heterogeneous Firms

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# Introduction

- Multinational Sales
- Trade Model of a firm's choice between exports and "horizontal" FDI

# The Model

- **Heterogeneous Firms**
- N Countries
- One input - L
- H Sectors with differentiated products and monopolistic competition
- 1 Homogenous goods sector; produced, traded everywhere
- An exogenous fraction of income is spent on H sector goods, the remainder on homogeneous goods
- Free Entry
- Ice Berg Trade Costs
- Proximity-Concentration trade-off
- Domestic Production , Export, Subsidiary

## The Model

- CES Preferences, Demand and Prices:

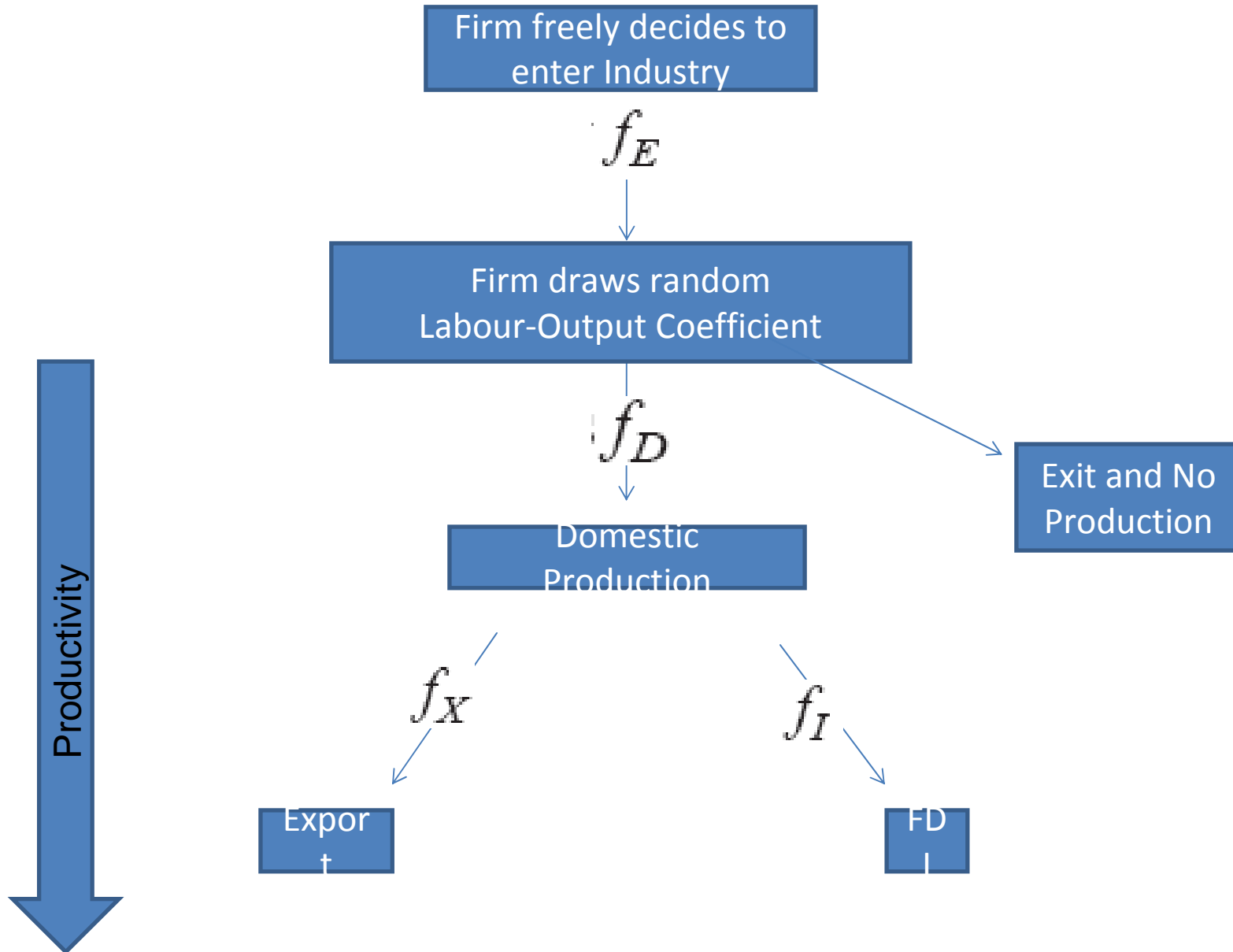
Elasticity of substitution:  $\varepsilon = 1/(1 - \alpha) > 1$

Demand for a brand in country i:  $A^i p^{-\varepsilon}$

Domestic/FDI Price:  $w^i a/\alpha$

Exporter price:  $\tau^j w^j a/\alpha$

# Access Decisions, Entry Costs and Productivity



## The Model

- Operating Profits with  $w=1$

Domestic Profits:  $\pi_D^i = a^{1-\varepsilon} B^i - f_D$

Additional Export Profits:  $\pi_X^{ij} = (\tau^{ij} a)^{1-\varepsilon} B^j - f_X$

Additional FDI Profits:  $\pi_I^j = a^{1-\varepsilon} B^j - f_I$

# Profits for identical demand levels

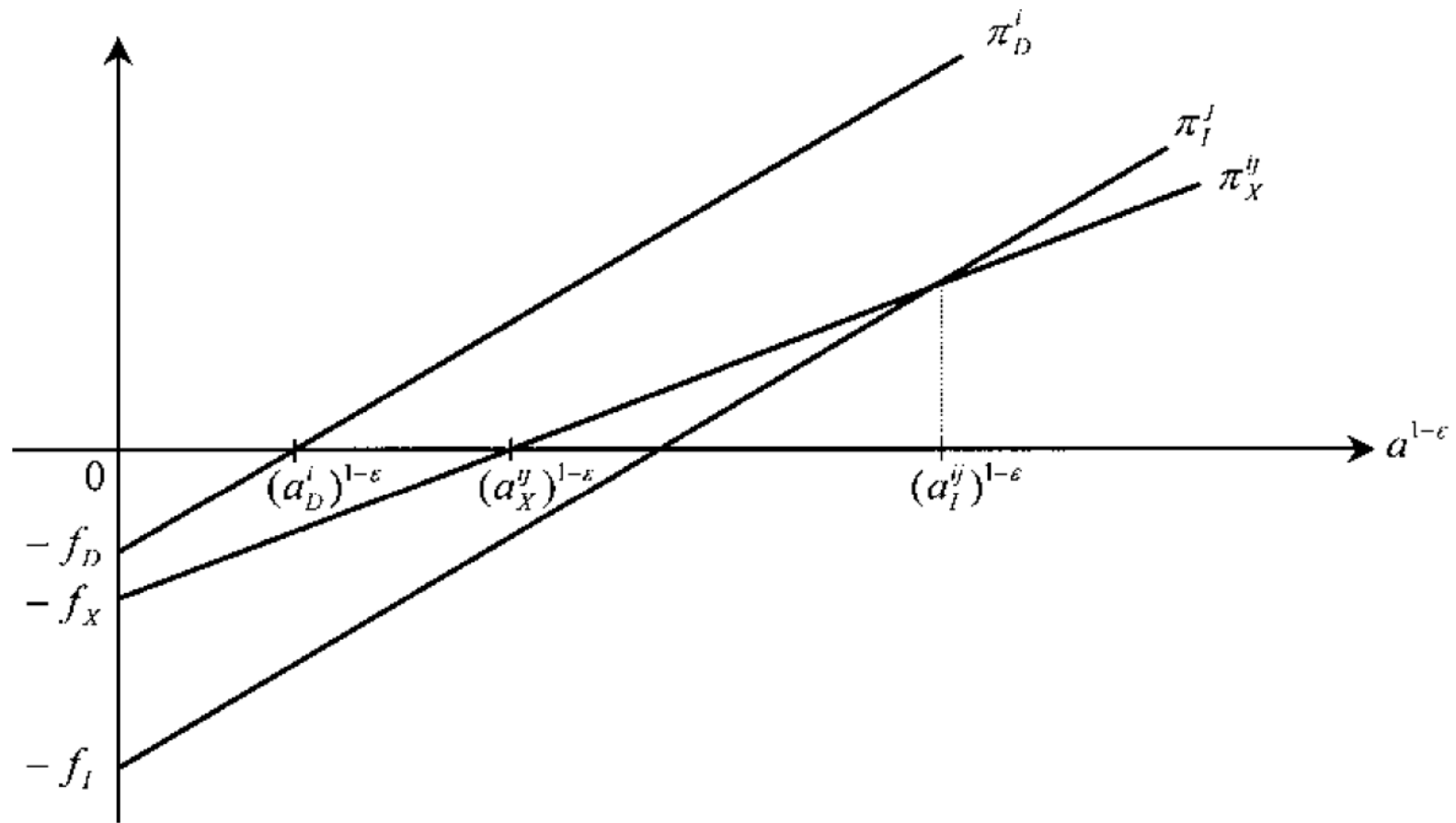


FIGURE 1. PROFITS FROM DOMESTIC SALES, FROM EXPORTS, AND FROM FDI

## Export vs. FDI

Relative magnitude of exports and local FDI sales for countries  $i$  and  $j$

$$(5) \quad \frac{S_X^{ij}}{S_I^{ij}} = \tau^{1-\varepsilon} \left[ \frac{V(a_X)}{V(a_I)} - 1 \right]$$

...assuming productivity  $1/a$  is drawn from a Pareto distribution with the shape parameter  $k$ , then  $V(a)$ , is also Pareto, with the shape parameter:  $k - (\varepsilon - 1)$

$$(7) \quad \frac{S_X^{ij}}{S_I^{ij}} = \tau^{1-\varepsilon} \left[ \left( \frac{a_X}{a_I} \right)^{k-(\varepsilon-1)} - 1 \right]$$
$$= \tau^{1-\varepsilon} \left[ \left( \frac{f_I - f_X}{f_X} \frac{1}{\tau^{\varepsilon-1} - 1} \right)^{\frac{k-(\varepsilon-1)}{\varepsilon-1}} - 1 \right]$$

# Testable Model Implications

- Testing determinants of the cross-sector and cross-country variation in relative export sales.
- Relaxing symmetry assumptions in wages, transport costs, and technology

$$\begin{aligned}
 (11) \quad \frac{S_X^{Uj}}{S_I^{Uj}} &= (\omega^j \tau_h^{Uj})^{1 - \varepsilon_h} \left[ \frac{V_h^U(a_{hX}^{Uj})}{V_h^U(a_{hI}^{Uj})} - 1 \right] \\
 &= (\omega^j \tau_h^{Uj})^{1 - \varepsilon_h} \left\{ \left[ \frac{f_{hP}}{f_X^j} \frac{1}{(\omega^j \tau_h^{Uj})^{\varepsilon_h - 1} - 1} \right]^{\frac{k_h^U - (\varepsilon_h - 1)}{\varepsilon_h - 1}} - 1 \right\}
 \end{aligned}$$

# Main Testable Model Implications

Within-sector firm productivity differences explain the structure of international trade and investment:

**(A) Only the most productive engage in foreign activities.**

**(B) Second, of those firms that serve foreign markets, only the most productive engage in FDI.**

**(C) Third, FDI sales relative to exports are larger in sectors with more firm heterogeneity.**

# Data

The required data fall into three categories:

**(A) the composition of international trade**

**(B) the proximity-concentration trade-off**

**(C) indices of firm-level heterogeneity**

## *The Composition of International Commerce*

- Few countries collect FDI data
- Bureau of Economic Analysis (BEA) collects affiliate level multinational sales data
- It is aggregated to industry level data to be comparable to export data
- Two samples: narrow sample vs. wide sample
- Wide sample includes more diverse, less developed countries, but has problems due to negative FDI

## *Proximity-Concentration Variables*

- How to measure fix costs?

### *transport costs*

=>**FREIGHT** = the ratio of CIF imports into the United States to FOB imports

=>**TARIFF** = the unweighted average of tariffs across sub-industries within the BEA industry.

=>Trade taxes are taken from Yeaple (2003b)

### *fixed costs of exporting and fixed costs of FDI*

- Costs could vary by industry and country; but unobservable

=> **one country fixed effect for both costs**

- Plant-level fixed cost to capture residual FDI cost, independent of productivity and firm size
- Cost of additional capacity
- =>**FP**=the average of the number non-production workers per establishment and the average number of non-production workers at the NAICS level within the BEA sector, weighted by the NAICS-level sales in the sector **(But this is related to prod and firm size!!!No Fix Costs!!!)**

## *Measures of Dispersion*

- Data to test the relationship between intra-industry firm heterogeneity and the prevalence of subsidiary sales relative to export sales
- No direct measure of intra industry productivity dispersion
- 2 equivalent dispersion proxies, assuming a Pareto distribution:
  - (1) Regress the log of an individual firm's rank within the distribution on the log of the firm's size. The estimated coefficient is exactly the measure of dispersion in the model, assuming a Pareto distribution:  $k - (\varepsilon - 1)$
  - (2) The second method is to compute s.d of the log of firm sales.

## *...Measures of Dispersion*

- Two data sources:

- (1) 1997 U.S. Census of Manufacturing,

- Problem: aggregated into ten different size categories. The authors assume that all establishments falling within the same size category have log sales equal to the mean for this category.

- =>semi-aggregated data

- (2) Two samples from the European Database Amadeus:

- Actual Firm Level Data

- all Western European firms

- French firms

# ...Measures of Dispersion

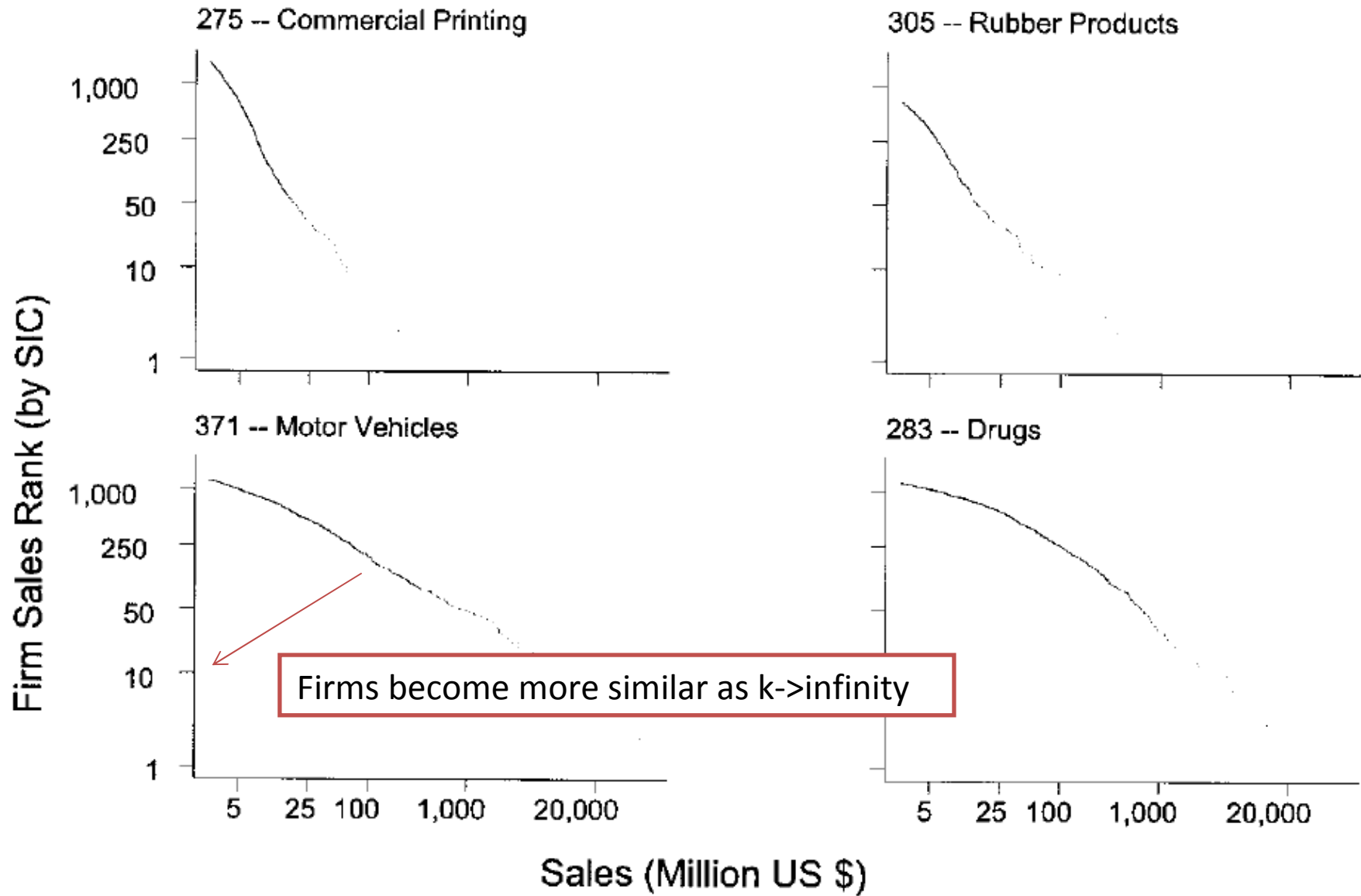


FIGURE 2. EMPIRICAL DISTRIBUTION OF FIRM SALES

## *...Measures of Dispersion*

- Can the US and EU data be compared?
  - US not actual firm level
  - Product Mix Problem
- Nevertheless, correlation is high between all measures!

## *Specification*

- Regression model is a Log version of:

$$(11) \quad \frac{S_X^{Uj}}{S_I^{Uj}} = (\omega^j \tau_h^{Uj})^{1 - \varepsilon_h} \left[ \frac{V_h^U(a_{hX}^{Uj})}{V_h^U(a_{hI}^{Uj})} - 1 \right]$$

$$= (\omega^j \tau_h^{Uj})^{1 - \varepsilon_h} \left\{ \left[ \frac{f_{hP}}{f_X^j} \frac{1}{(\omega^j \tau_h^{Uj})^{\varepsilon_h - 1} - 1} \right]^{\frac{k_h^U - (\varepsilon_h - 1)}{\varepsilon_h - 1}} - 1 \right\}$$

- LHS: log of exports relative to FDI
- RHS: firm-size dispersion (-), the log of the FDI plant fixed costs(+), logarithms of transport costs(-) and tariff costs(-), country dummies to control for the differences in  $fX$
- Controls: Sectoral Capital and R&D intensities

# Results

TABLE 3—EXPORTS VERSUS FDI

		Narrow sample (N = 961)				
		U.S. std. dev.	Europe std. dev.	France std. dev.	Europe reg. coeff.	France reg. coeff.
P-C Trade Off	FREIGHT	-1.040 (-7.392)	-0.959 (-6.749)	-1.019 (-7.328)	-0.935 (-6.526)	-0.944 (-6.594)
	TARIFF	-0.365 (-2.644)	-0.512 (-3.636)	-0.421 (-3.917)	-0.545 (-3.781)	-0.539 (-3.775)
Firm Heterogeneity	FP	1.177 (10.159)	0.932 (7.827)	0.927 (8.059)	0.947 (7.453)	0.934 (7.450)
	DISPERSE	-2.343 (-8.374)	-2.153 (-5.250)	-2.061 (-6.664)	-1.503 (-4.535)	-1.491 (-4.470)
Controls	KL	-0.868 (-7.790)	-0.495 (-4.529)	-0.456 (-4.256)	-0.628 (-5.876)	-0.626 (-5.859)
	RD	-0.104 (-2.197)	0.007 (0.150)	0.007 (0.144)	0.006 (0.125)	-0.002 (-0.047)
$R^2$		0.373	0.340	0.364	0.332	0.334
		Wide sample (N = 1,175)				
		U.S. std. dev.	Europe std. dev.	France std. dev.	Europe reg. coeff.	France reg. coeff.
	FREIGHT	-1.011 (-7.968)	-0.935 (-7.246)	-0.960 (-7.714)	-0.915 (-7.040)	-0.919 (-7.053)
	TARIFF	-0.241 (-1.876)	-0.384 (-2.964)	-0.306 (-2.457)	-0.411 (-3.073)	-0.407 (-3.057)
	FP	1.133 (10.428)	0.861 (7.719)	0.868 (7.994)	0.867 (7.318)	0.848 (7.243)
	DISPERSE	-2.248 (-8.611)	-1.866 (-4.919)	-1.833 (-5.982)	-1.284 (-4.132)	-1.215 (-3.924)
	KL	-0.793 (-7.483)	-0.454 (-4.347)	-0.412 (-3.982)	-0.569 (-5.574)	-0.576 (-5.636)
	RD	-0.086 (-1.914)	0.017 (0.367)	0.021 (0.446)	0.015 (0.326)	0.007 (0.153)
$R^2$		0.338	0.305	0.325	0.298	0.298

Notes: *T*-statistics are in parentheses (calculated on the basis of White standard errors). Constant and country dummies are suppressed.

## *Economic Interpretation*

TABLE 4—“BETA” COEFFICIENTS: NARROW SAMPLE WITH CONTROLS

	Mean	Standard deviation	“Beta” coefficient
Dependent variable	-0.595	2.375	
FREIGHT	1.863	0.653	-0.271
TARIFF	2.015	1.020	-0.205
FP	3.321	0.785	0.325
U.S. s.d.	1.749	0.316	-0.312
Europe s.d.	1.198	0.276	-0.250
France s.d.	1.224	0.375	-0.325
Europe reg.	1.260	0.333	-0.210
France reg.	1.257	0.336	-0.211

-Converts the coeffs into units of sample standard deviation

- Formula:  $\text{coeff.} \cdot \text{s.d. of independent variable} / \text{s.d. of dependent variable}$

# Estimation Problems

- Results strongly support the model
- Degree of variations across industry might not be captured by the model
- Controls:
  - Controls not in the model
  - RD not significant
  - How to interpret Capital intensity?
  - Enough Controls to capture differences across sectors?

=>Random Industry Effects to address unmeasured sectoral characteristics:

- Fixed Effects would preclude dispersion
- Efficient estimation in the presence of common sectoral components in the residuals!
- But are random effects uncorrelated with RHS variables like Dispersion?

# Results with Random Effects

TABLE 5—EXPORTS VERSUS FDI—RANDOM EFFECTS

Narrow sample (N = 961)					
	U.S. std. dev.	Europe std. dev.	France std. dev.	Europe reg. coeff.	France reg. coeff.
FREIGHT	-0.430 (-2.554)	-0.398 (-2.344)	-0.428 (-2.533)	-0.397 (-2.336)	-0.397 (-2.334)
TARIFF	-0.113 (-0.922)	-0.127 (-1.033)	-0.105 (-0.857)	-0.136 (-1.107)	-0.133 (-1.085)
FP	1.376 (5.145)	1.132 (4.128)	1.096 (4.233)	1.154 (4.107)	1.137 (4.093)
DISPERSE	-2.623 (-4.897)	-2.763 (-3.459)	-2.445 (-4.761)	-2.031 (-3.098)	-1.991 (-3.180)
KL	-1.106 (-4.652)	-0.613 (-2.238)	-0.570 (-2.168)	-0.757 (-2.891)	-0.758 (-2.896)
RD	-0.002 (-0.020)	0.126 (1.029)	0.116 (0.970)	0.133 (1.081)	0.119 (0.972)
$R^2$	0.352	0.316	0.342	0.307	0.308
Wide sample (N = 1,175)					
	U.S. std. dev.	Europe std. dev.	France std. dev.	Europe reg. coeff.	France reg. coeff.
FREIGHT	-0.331 (-2.296)	-0.322 (-2.230)	-0.328 (-2.278)	-0.320 (-2.215)	-0.320 (-2.215)
TARIFF	-0.004 (-0.038)	-0.018 (-0.155)	-0.004 (-0.035)	-0.022 (-0.193)	-0.021 (-0.187)
FP	1.361 (4.123)	1.110 (3.455)	1.081 (3.475)	1.127 (3.377)	1.103 (3.369)
DISPERSE	-2.518 (-3.824)	-2.559 (-2.733)	-2.265 (-3.706)	-1.864 (-2.398)	-1.786 (-2.424)
KL	-1.069 (-3.660)	-0.599 (-1.871)	-0.561 (-1.789)	-0.734 (-2.373)	-0.739 (-2.408)
RD	0.006 (0.042)	0.123 (0.862)	0.116 (0.811)	0.129 (0.894)	0.115 (0.805)
$R^2$	0.312	0.274	0.297	0.267	0.267

Insignificant



Notes: *T*-statistics are in parentheses. Constant and country dummies are suppressed.

## Estimation Issues

- Interdependence of the residuals across countries remains due to Re-exports? (see working paper)
- Sources of endogeneity bias in the dispersion measures and measurement errors
  - Instruments: European Dispersion Measures
  - Clustered errors within sectors
- Intra firm trade
  - very important, but not modelled
  - netted out of FDI ; controlling for 4-firm concentration
  - > results unchanged

# Robustness Results with clustered errors and IVs

TABLE 6—EXPORTS VERSUS FDI—ADDITIONAL ROBUSTNESS RESULTS  
(Clustered standard errors and IV specifications)

	OLS			IV		
	Narrow sample	Wide sample	Aggregated Europe	Narrow sample	Wide sample	Aggregated Europe
FREIGHT	-1.040 (-3.997)	-1.011 (-4.437)	-1.001 (-4.464)	-1.218 (-3.862)	-1.118 (-4.366)	-1.053 (-4.545)
TARIFF	-0.365 (-1.611)	-0.241 (-1.081)	-0.077 (-0.304)	-0.188 (-0.706)	-0.124 (-0.478)	-0.016 (-0.056)
FP	1.177 (4.876)	1.133 (4.472)	1.086 (4.166)	1.609 (3.605)	1.457 (3.311)	1.344 (3.182)
DISPERSE (U.S.)	-2.343 (-3.689)	-2.248 (-3.655)	-2.150 (-3.349)	-4.321 (-2.606)	-3.681 (-2.248)	-3.198 (-2.217)
KL	-0.868 (-3.032)	-0.793 (-2.513)	-0.848 (-2.593)	-0.938 (-2.855)	-0.848 (-2.496)	-0.890 (-2.599)
RD	-0.104 (-0.851)	-0.086 (-0.687)	-0.087 (-0.691)	-0.158 (-1.233)	-0.127 (-0.985)	-0.121 (-0.968)
$R^2$	0.373	0.338	0.314	0.328	0.315	0.315
N	961	1,175	678	961	1,175	678

*Notes:* In the IV specifications, the U.S. dispersion measure is instrumented using all four European dispersion measures. All *T*-statistics (in parentheses) are computed from standard errors that are heteroskedasticity consistent and adjusted for clustering by industry. Constant and country dummies are suppressed.

# Conclusion

- Standard proximity-concentration trade-off
  - Domestic Producer vs. Exporter vs. FDI
  - **NEW: Within-sector heterogeneity of productivity levels**
  - Estimates the effects of trade frictions, economies of scale, and within-industry dispersion of firm size, on exports versus FDI sales.
  - Robust cross-sectoral relationship between the degree of dispersion in firm size and the tendency of firms to substitute FDI sales for exports.
  - The size of this effect is of the same order of magnitude as trade frictions.
- => Within-sectoral heterogeneity plays an important role in the structure of foreign trade and investment.**