Firm-to-Firm Trade:

Imports, Exports, and the Labor Market

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Objectives

- Model firms in a network both selling outputs and buying inputs
- Connect these interactions with firm employment
- Interpret the facts on firm-level exporting and importing
- Do it in a general-equilibrium setting
- At this point its still largely an untested theory ...

A Peek at the Data

Thanks to: Kramarz, Martin, Mejean (2014)

Table 1: Customers per French Exporter

	Destination Market			
	Lithuania	Denmark	UK	Germany
Market Size ($billions)	18	94	882	1480
Customers per Exporter:				
Mean	4.2	7.1	17.9	24.9
Percentiles:				
25th	1	1	1	2
50th	2	2	3	4
75th	4	5	9	12
90th	9	12	25	35
95th	15	21	48	70
99th	40	77	224	329

Data are for 2005.

Figure 2: French Exporters and Market Size

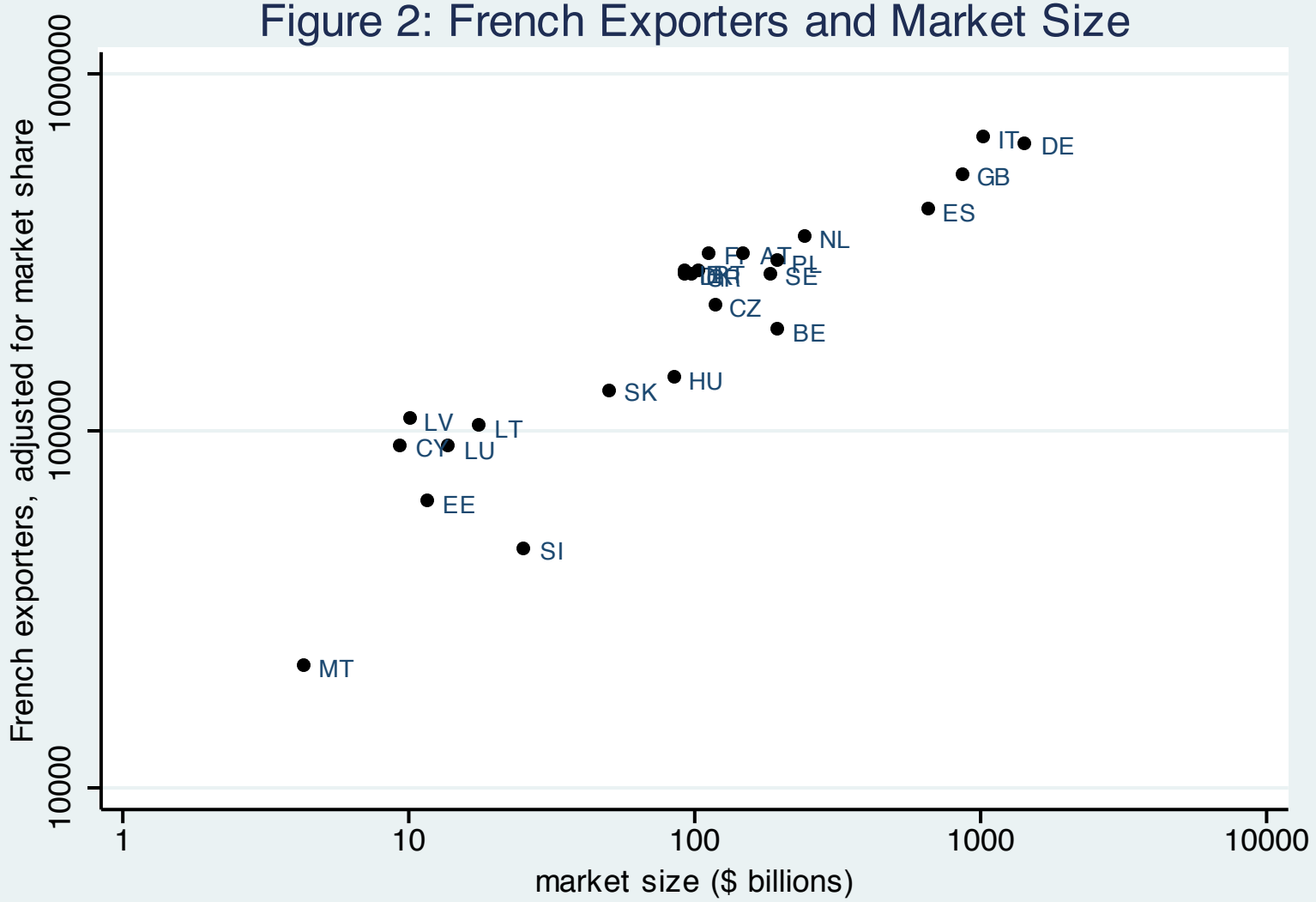
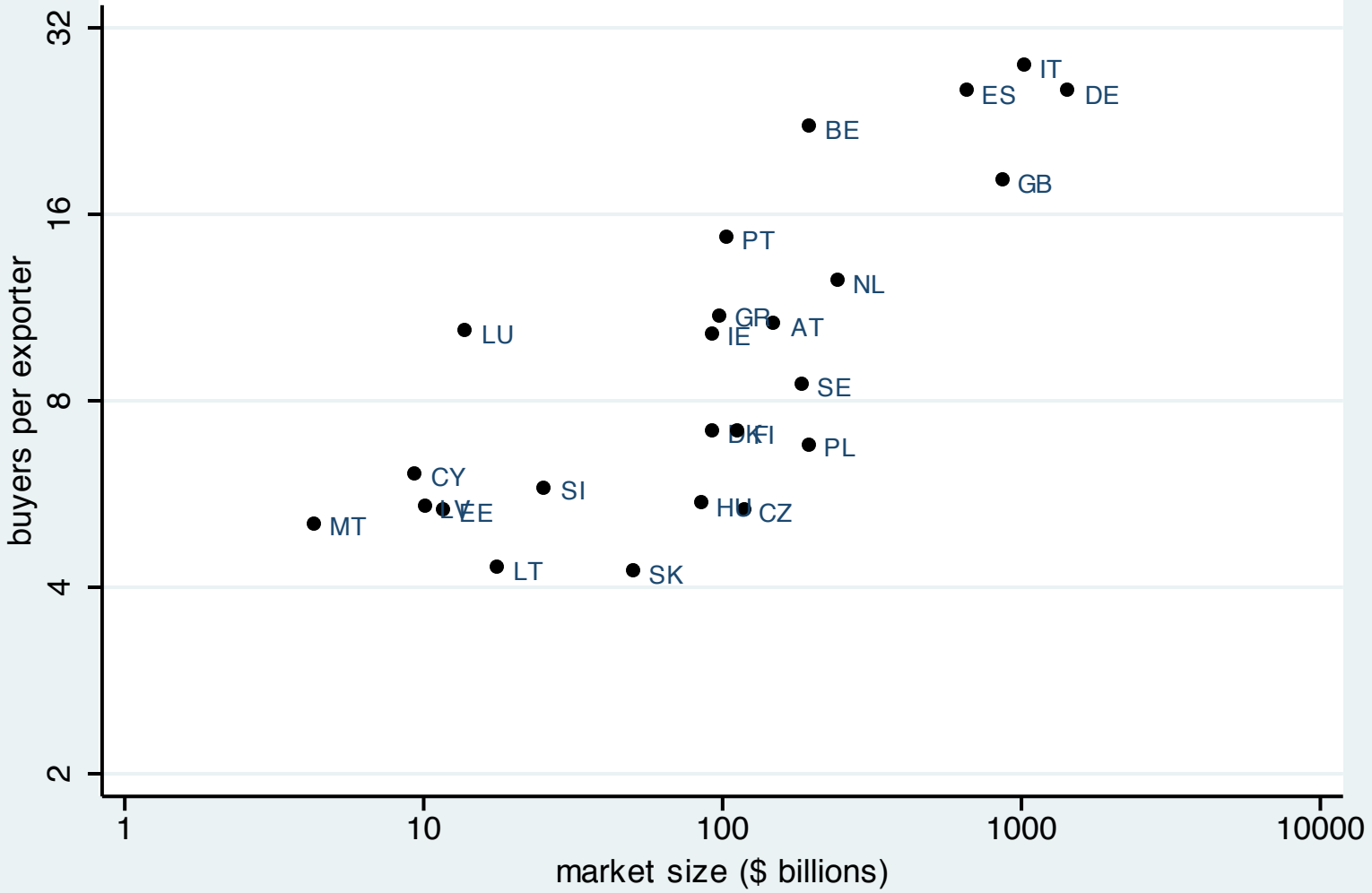


Figure 3: Buyers per French Exporter, by Destination



Related Literature

- **Firm-level imports:** Biscourp and Kramarz (2007); Hummels, Jorgenson, Munch, and Xiang (2011); Blaum, Lelarge, and Peters (2014); Kramarz, Martin, and Mejean (2015); Antras, Fort, Tintelnot (2015).

- **Networks:** Chaney (2014); Eaton, Eslava, Jinkins, Krizan, and Tybout (2014); Bernard, Moxnes, and Ulltveit-Moe (2014)

- **Theoretical elements:** BEJK (2003); Melitz (2003); EKK (2011); EKS (2013); Garretto (2013); Oberfield (2014)

A Model of Firm-to-Firm Trade

Production

- Many countries $i = 1, ..., \mathcal{N}$, trading subject to iceberg trade costs, d_{ni}
- Firm j in country i produces CRS:

$$Q_i(j) = z_i(j) \prod_{k=1}^{K} m_{k,i}(j)^{\beta_k}$$

- Country i endowed with measure of firms with efficiency above z:

$$\mu_i^z(z) = T_i z^{-\theta}$$

- The task k input $m_{k,i}(j)$ is purchased at cost $c_{k,i}(j)$

Simple Example

- Task 1 perfomed by labor, $c_{1,i}(j) = w_i$
- Task 2 by intermediate good, $c_{2,i}(j) = p_i$
- Implies that a measure $\mu_n(c)$ of firms can supply n at a cost below c:

$$\mu_n(c) = \left(\sum_{i=1}^{\mathcal{N}} T_i \left(w_i^{\beta} p_i^{1-\beta} d_{ni} \right)^{-\theta} \right) c^{\theta}$$

Assessment

- With fixed cost of selling and monopolistic competition, Melitz-Chaney ...
- ... which describes behavior of French exporters in EKK
- But fails to capture:
  - granularity of demand (few customers per firm)
  - network of firms supplying each other unique inputs
  - firm-level importing and exporting

Back to the Model

- Drop fixed cost of selling and monopolistic competition, but add idiosyncratic costs of carrying out tasks:

$$c_{k,i}(j) = \min \left\{ \frac{w_{k,i}}{q_{k,i}(j)}, p_{k,i}^{\min}(j) \right\}$$

- ... where assume i.i.d.:

$$\Pr \left[q_{k,i}(j) \leq q \right] = F(q)$$

- ... and derive:

$$\Pr \left[c_{k,i}(j) \leq c \right] = G_{k,i}(c)$$

Matching: Buyers finding Suppliers

- A firm in i looking for low cost suppliers of intermediates to carry out task k is exposed to suppliers with cost c at intensity

$$e_{k,i}(c) = \lambda_{k,i}\mu_i(c)^{-\gamma}$$

- Measure $\mu_i(c)$ of firms can supply i at a cost below c, but firm is aware of a countable number, distributed Poisson with parameter:

$$\rho_{k,i}(c) = \int_0^c e_{k,i}(x)d\mu_i(x) = \frac{\lambda_{k,i}}{1-\gamma}\mu_i(c)^{1-\gamma}$$

- Assume buyer has all the bargaining power so price equals cost

Key Result

- If:

$$F(q) = e^{-q^{-\phi}} = e^{-q^{-\theta(1-\gamma)}}$$

- Then:

$$\mu_n(c) = \Upsilon_n c^{\theta}$$

with

$$\Upsilon_n = \sum_i T_i d_{ni}^{-\theta} \prod_{k=1}^{K} \left(\frac{\theta}{\phi} \lambda_{k,i} \Upsilon_i^{\phi/\theta} + w_{k,i}^{-\phi} \right)^{\frac{\theta}{\phi}\beta_k}$$

Discussion

- System of Υ's is well behaved, given wages, if for each i, $\lambda_{k,i} = 0$ for some k

- If all $\lambda_{k,i}$'s are zero, then back to our simple example, with $\beta = 1$ and:

$$w_i = \prod_{k=1}^{K} w_{k,i}^{\beta_k}$$

- Otherwise, every Υ increasing in any T_i or $\lambda_{k,i}$

Implications: Distributions

- Price of low-cost intermediate for task k:

$$\Pr\left[p_{k,i}^{\min}(j) \leq p\right] = 1 - e^{-\rho_{k,i}(p)} = 1 - e^{-\frac{\theta}{\phi}\lambda_{k,i}\Upsilon_i^{\phi/\theta}p^{\phi}}$$

- Cost of carrying out task k:

$$\Pr\left[c_{k,i}(j) \leq c\right] = G_{k,i}(c) = 1 - e^{-\Xi_{k,i}c_k^{\phi}}$$

- ... where

$$\Xi_{k,i} = \frac{\theta}{\phi}\lambda_{k,i}\Upsilon_i^{\phi/\theta} + w_{k,i}^{-\phi}$$

Implications: Shares

- Probability $w_{k,i}^{-\phi}/\Xi_{k,i}$ that a firm performs task k using its workers
- Aggregate labor share:

$$\beta_i^L = \sum_{k=1}^{K} \beta_k \frac{w_{k,i}^{-\phi}}{\Xi_{k,i}}$$

- Measure of firms from i that can supply n at cost below c:

$$\mu_{ni}(c) = \left(T_i d_{ni}^{-\theta} \prod_{k=1}^{K} \Xi_{k,i}^{\frac{\theta}{\phi}\beta_k} \right) c^{\theta}$$

- Trade share: $\pi_{ni} = \mu_{ni}(c)/\mu_n(c)$

Closing the Model

Households and the Cost of Living

- Utility function is like the production function but with α_k in place of β_k
- Households choose final goods like firms choosing intermediates
- Exact price index for households:

$$P_n^C = \prod_k \left(\Xi_{k,n}\right)^{-\alpha_k/\phi}$$

Goods Market Clearing

- Total production in country i:

$$Y_i = \sum_{n=1}^{N} \pi_{ni} \left[(1 - \alpha_n^L) X_n^C + (1 - \beta_n^L) Y_n \right]$$

- ... where β_n^L is labor share in production and α_n^L is defined in parallel, with α_k in place of β_k

- Country i is endowed with L_i^l workers of type l who are able to perform tasks $k \in \Omega_l$

- Next, solve for equilibrium wages w_i^l, where $w_{k,i} = w_i^l$ for $k \in \Omega_l$

Labor Market Clearing

- Trade balance and income:

$$X_i^C = Y_i^L = \sum_l w_i^l L_i^l$$

- Labor market equilibrium:

$$w_i^l L_i^l = \alpha_i^l Y_i^L + \beta_i^l Y_i$$

- Here β_i^l (and likewise α_i^l, with α_k in place of β_k) are given by:

$$\beta_i^l = \sum_{k \in \Omega_l} \beta_k \frac{w_{k,i}^{-\phi}}{\Xi_{k,i}}$$

Numerical Exploration of Aggregates

Table 2: Baseline Parameter Settings for Simulation

Parameter	symbol	value
Pareto parameters:		
efficiency distribution	theta	5
price distribution	phi	2
Technology level per person	T_i/L_i	3.6
World labor force	L	1
Labor by type (fractions of labor force):	L^l	
nonproduction (service)		0.6
production		0.4
Iceberg trade cost	d	1.2
Tasks, by type:		
service tasks:		
number of tasks	K	4
total share	beta	0.4
production tasks:		
number of tasks	K	12
total share	beta	0.6
Task shares in consumption (same as for production)	alpha	
Outsourcing parameters:	lambda	
service		0
production		0.2

Table 3: Aggregate Results of Simulation

	Country Size					
	L=0.001	L=0.009	L=0.09	L=0.2	L=0.3	L=0.4
Production value added:						
Share of GDP	0.126	0.126	0.128	0.130	0.131	0.132
Share of gross production	0.31	0.31	0.30	0.29	0.28	0.28
Fraction of production tasks outsourced:	0.48	0.48	0.50	0.51	0.53	0.54

1. Production value added does not include service tasks (i.e. purchased services)
2. Wage is normalized so that labor income of the World is 1

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Share of gross production	0.31	0.31	0.30	0.29	0.28	0.28
Fraction of production tasks outsourced:	0.48	0.48	0.50	0.51	0.53	0.54
Import share of production	1.00	0.97	0.79	0.61	0.49	0.39

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Fraction of production tasks outsourced:	0.48	0.48	0.50	0.51	0.53	0.54
Import share of production	1.00	0.97	0.79	0.61	0.49	0.39
Wage:						
service	0.87	0.87	0.91	0.94	0.98	1.00
production	1.02	1.02	1.03	1.03	1.04	1.05
Skill premium (service/production)	0.85	0.86	0.88	0.91	0.94	0.96

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Import share of production	1.00	0.97	0.79	0.61	0.49	0.39
Wage:						
service	0.87	0.87	0.91	0.94	0.98	1.00
production	1.02	1.02	1.03	1.03	1.04	1.05
Skill premium (service/production)	0.85	0.86	0.88	0.91	0.94	0.96
Real wage:						
service	1.45	1.46	1.50	1.55	1.58	1.62
production	1.71	1.71	1.70	1.69	1.69	1.69
Welfare (real per capita consumption)	1.55	1.56	1.58	1.61	1.63	1.64

1. Production value added does not include service tasks (i.e. purchased services)

2. Wage is normalized so that labor income of the World is 1

Table 4: Aggregate Results with Different Trade Costs

	Trade Cost (small country, L=.009)					Trade Cost (large country, L=0.3)				
	10.00	1.80	1.20	1.05	1.00	10.00	1.80	1.20	1.05	1.00
Production value added:										
Share of GDP	0.06	0.09	0.13	0.13	0.13	0.12	0.13	0.13	0.13	0.13
Share of gross production	0.49	0.43	0.31	0.27	0.26	0.32	0.31	0.28	0.26	0.26
Fraction of prod. tasks outsourced:	0.19	0.29	0.48	0.55	0.57	0.47	0.48	0.53	0.56	0.57

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Production value added:										
Share of GDP	0.06	0.09	0.13	0.13	0.13	0.12	0.13	0.13	0.13	0.13
Share of gross production	0.49	0.43	0.31	0.27	0.26	0.32	0.31	0.28	0.26	0.26
Fraction of prod. tasks outsourced:	0.19	0.29	0.48	0.55	0.57	0.47	0.48	0.53	0.56	0.57
Import share of production	0.00	0.76	0.97	0.99	0.99	0.00	0.11	0.49	0.65	0.70

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Production value added:										
Share of GDP	0.06	0.09	0.13	0.13	0.13	0.12	0.13	0.13	0.13	0.13
Share of gross production	0.49	0.43	0.31	0.27	0.26	0.32	0.31	0.28	0.26	0.26
Fraction of prod. tasks outsourced:	0.19	0.29	0.48	0.55	0.57	0.47	0.48	0.53	0.56	0.57
Import share of production	0.00	0.76	0.97	0.99	0.99	0.00	0.11	0.49	0.65	0.70
Wage:										
service	0.73	0.62	0.87	0.98	1.02	0.93	0.94	0.98	1.00	1.02
production	1.34	1.00	1.02	0.99	0.97	1.11	1.11	1.04	0.99	0.97
Skill premium (service/production)	0.55	0.62	0.86	0.99	1.04	0.83	0.85	0.94	1.01	1.04

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Import share of production	0.00	0.76	0.97	0.99	0.99	0.00	0.11	0.49	0.65	0.70
Wage:										
service	0.73	0.62	0.87	0.98	1.02	0.93	0.94	0.98	1.00	1.02
production	1.34	1.00	1.02	0.99	0.97	1.11	1.11	1.04	0.99	0.97
Skill premium (service/production)	0.55	0.62	0.86	0.99	1.04	0.83	0.85	0.94	1.01	1.04
Real wage:										
service	0.98	1.10	1.46	1.66	1.74	1.42	1.45	1.58	1.69	1.74
production	1.78	1.76	1.71	1.68	1.67	1.71	1.71	1.69	1.68	1.67
Welfare (real per capita cons.)	1.30	1.36	1.56	1.67	1.71	1.54	1.55	1.63	1.69	1.71

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Firm-Level Implications

Matching: Suppliers finding Buyers

- Poisson number of **potential** customers in n (task k) for a firm delivering there at cost c:

$$(L_n + M_n)\, e_{k,n}(c)$$

- Poisson number of **actual** customers in n (any task) for a firm delivering there at cost c:

$$\eta_n(c) = (L_n + M_n) \sum_k e_{k,n}(c) \left[1 - G_{k,n}(c)\right]$$

- Probability of this firm having at least one customer in n:

$$1 - e^{-\eta_n(c)}$$

Measure of Producers by Source

- Poisson number of customers anywhere for a firm from i with cost c in the home market:

$$\eta_i^W(c) = \sum_n \eta_n(cd_{ni})$$

- Measure of firms producing in i:

$$M_i = \int_0^\infty \left(1 - e^{-\eta_i^W(c)}\right) d\mu_{ii}(c)$$

Firm Entry by Destination Market

- Measure of firms from i selling in n:

$$N_{ni} = \int_0^\infty \left(1 - e^{-\eta_n(c)}\right) d\mu_{ni}(c)$$

- We can compute entry, and how it relates to market size

- ... even though the model has no fixed cost of selling in a market

Table 5: Firm-Level Results of Simulation

	Country Size					
	L=0.001	L=0.009	L=0.09	L=0.2	L=0.3	L=0.4
Measures of firms:						
producing	0.02	0.14	1.60	3.95	6.32	8.80
selling	0.08	0.61	3.93	7.38	10.15	12.67

Table 5: Firm-Level Results of Simulation

	Country Size					
	L=0.001	L=0.009	L=0.09	L=0.2	L=0.3	L=0.4
Measures of firms:						
producing	0.02	0.14	1.60	3.95	6.32	8.80
selling	0.08	0.61	3.93	7.38	10.15	12.67
Measures normalized by Labor:						
producing	15.7	15.9	17.8	19.8	21.1	22.0
selling	84.9	67.6	43.7	36.9	33.8	31.7

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producing	15.7	15.9	17.8	19.8	21.1	22.0
selling	84.9	67.6	43.7	36.9	33.8	31.7
Fraction of firms selling domestically:	0.02	0.11	0.53	0.74	0.83	0.88

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producing	15.7	15.9	17.8	19.8	21.1	22.0
selling	84.9	67.6	43.7	36.9	33.8	31.7
Fraction of firms selling domestically:	0.02	0.11	0.53	0.74	0.83	0.88
Mean # customers per firm:	1.13	1.44	2.56	3.47	4.12	4.68
Size distribution (percentiles):						
25th	1	1	1	1	1	1
50th	1	1	1	1	1	1
75th	1	1	2	2	3	3
90th	1	2	4	5	6	7
95th	2	3	7	10	12	14
99th	3	8	22	34	43	51

Table 6: Firm-Level Results with Different Trade Costs

	Trade Cost (small country, L=.009)					Trade Cost (large country, L=0.3)				
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Measures of firms:										
producing	0.29	0.09	0.14	0.19	0.22	11.4	9.6	6.3	6.8	7.3
selling	0.29	0.21	0.61	0.91	1.07	11.4	10.8	10.1	11.7	12.7

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selling	0.29	0.21	0.61	0.91	1.07	11.4	10.8	10.1	11.7	12.7
Measures normalized by Labor:										
producing	31.9	9.5	15.9	21.6	24.4	37.9	32.0	21.1	22.6	24.4
selling	31.9	23.7	67.6	101.6	118.5	37.9	36.1	33.8	38.9	42.4

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Fraction of firms selling domestically:	1.00	0.60	0.11	0.06	0.04	1.00	1.00	0.83	0.61	0.52

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Fraction of firms selling domestically:	1.00	0.60	0.11	0.06	0.04	1.00	1.00	0.83	0.61	0.52
Mean # customers per firm:	2.33	1.52	1.44	1.47	1.48	5.73	5.23	4.12	4.08	4.14
Size distribution (percentiles):										
25th	1	1	1	1	1	1	1	1	1	1
50th	1	1	1	1	1	1	1	1	1	1
75th	2	1	1	1	1	3	3	3	3	3
90th	4	2	2	2	2	9	8	6	6	6
95th	6	3	3	3	3	17	16	12	12	12
99th	19	9	8	8	8	66	59	43	43	44

Figure 2: French Exporters and Market Size

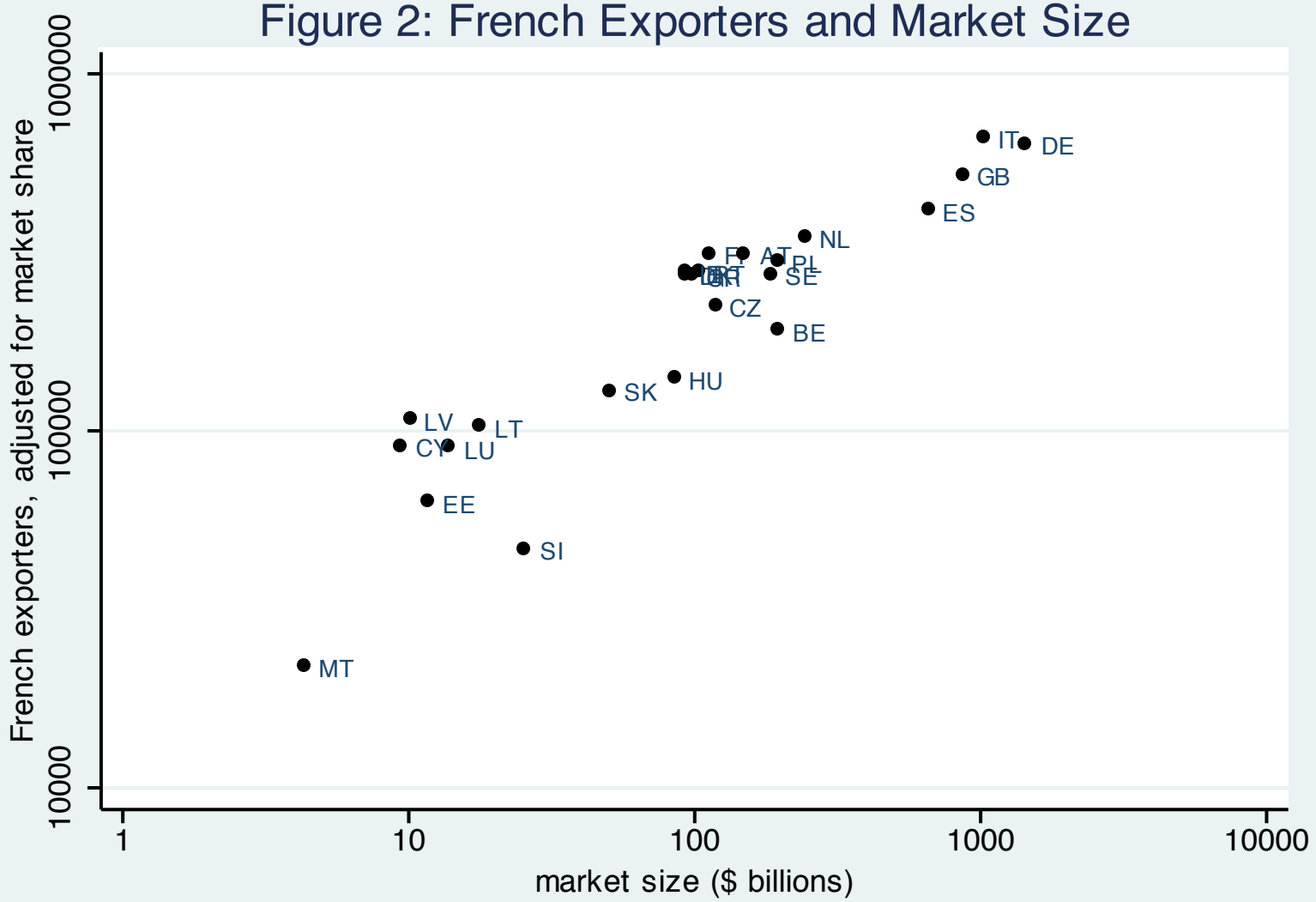

Figure 3: Buyers per French Exporter, by Destination

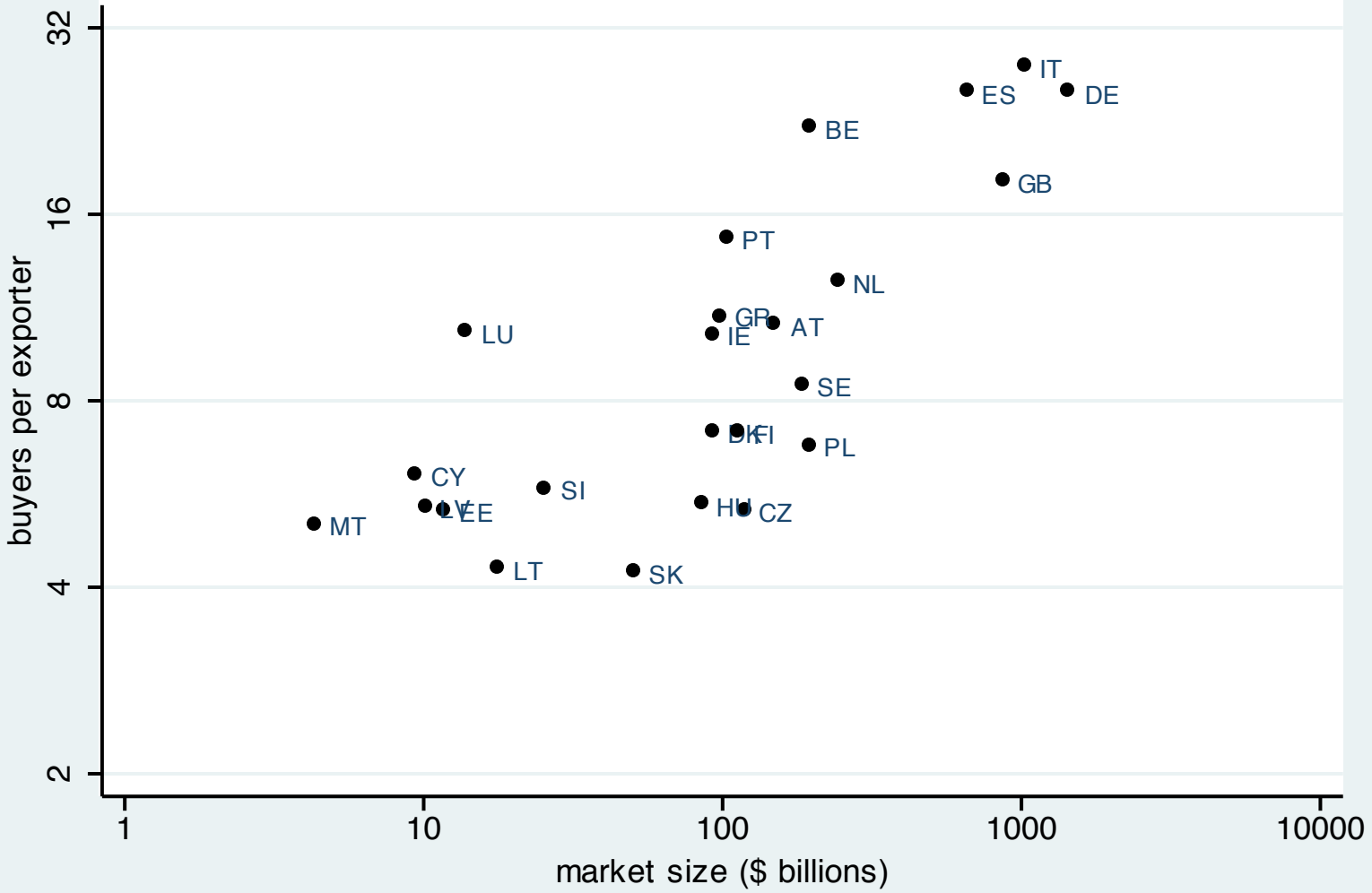

Figure 5: Suppliers and Market Size

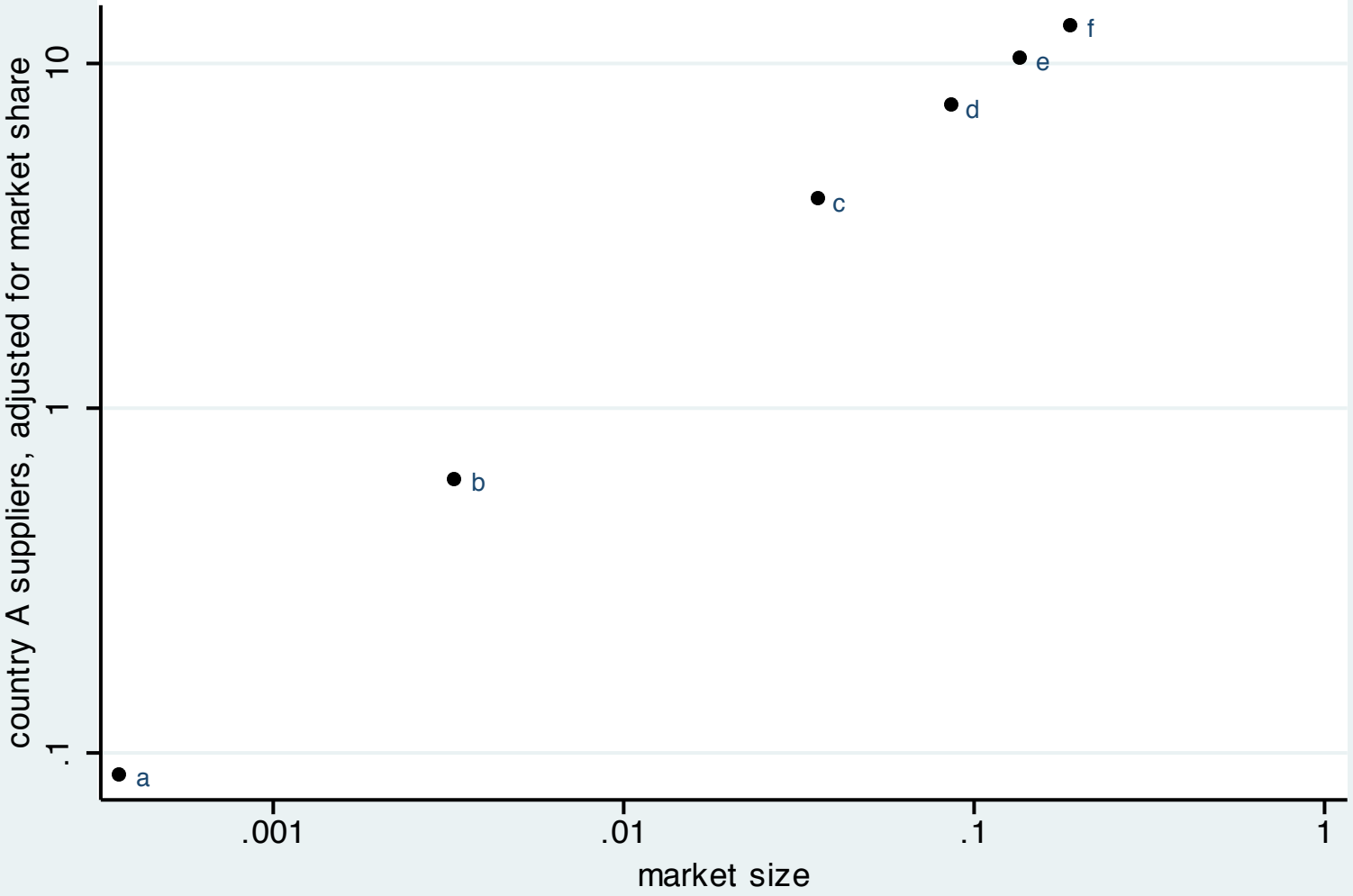

Figure 6: Buyers per Supplier, by Destination