Firm-to-Firm Trade: Imports, Exports, and the Labor Market

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ERWIT

October, 2020

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Theoretical Vision

Trade is the result of a global search by firms for suppliers and for customers:

- Suppliers of intermediates potentially replace firms' production workers
- The same firms act both as buyers and as suppliers, importers and exporters
- Search is stochastic but buyers can choose the best supplier(s) they encounter
- Outcomes are granular: finite integer number of suppliers and buyers
- Firm's choices shape production technology;
  - if it is cost effective a firm can replace workers …

    … and perform a task with an intermediate purchased domestically or imported
- Many dimensions of heterogeneity:
  - firm efficiency and number of tasks (totally exogenous);
  - Firm unit costs, labor share of costs, number of buyers, and number of suppliers (partly endogenous)

Implementation

Parsimonious, analytically tractable model:

- Small set of parameters other than bilateral search frictions
- Wholesalers interact with producers; retailers sell final goods to households, absent Dixit-Stiglitz preferences
- No fixed costs, as search frictions do the job

Empirical scope; *Connects to granular buyer-seller transactions and to aggregates:*

- To firm level data on exporting and labor shares;
- to aggregate bilateral trade around the world

The empirical analogs of all the objects in the theory

Implications

Explains existing findings, solves puzzles, and extends the reach of existing theory

- Some predictions of Melitz's model survive (selection into export); yet search frictions act like (replace) a fixed cost to enter a market, with no role for profits
- Why doesn't number of exporters scale with bilateral trade share (as predicted in Melitz or EKKI)? the first buyer in a market makes firm an exporter, so subsequent buyers don't matter for export status
- Why is there such huge variation in sales per exporter (X/N) across country pairs, which is positively correlated with bilateral trade flows?
  - In existing theory (Melitz) sales per exporter is invariant to iceberg costs, but positively correlated with bilateral fixed costs
  - Greater variation in bilateral fixed costs will explain the huge variation in X/N, but would dampen variation in bilateral trade, requiring even more variation in iceberg trade costs to fit the bilateral trade (yet variation in such costs is already thought to be implausibly high)
  - In our theory, sales per exporter is invariant to iceberg costs, but is negatively related to bilateral search frictions, letting us explain the data while reducing the reliance on iceberg trade costs
- We can identify bilateral search frictions from the variation in buyers per exporter
- We can speak of trade and labor simultaneously both at the firm level and in general equilibrium

Literature

- Chaney: vision of trade as due to random connections between exporters and buyers
- Oberfield: derives as similar fixed point; who the buyer purchases from influences its cost, altering its success as a seller
- Bernard et al: uncovered facts for Norwegian sellers, and their buyers; data on French sellers closely align with them
- Tybout and Eaton
- Mejean et al: same search technology, implies that smaller firms are inefficiently protected by search frictions; applied at the level of individual goods
- Van Reenen: Literature on superstar firms, leading to reductions in labor’s share
- Acemoglu and Autor: role of tasks in production

Preview of a Key Result

Why do bilateral sales per exporter (X/N) vary so much across country pairs?

- Based on our theory, we can write *X/N* as:

$$\frac{X_{ni}}{N_{ni}} = \frac{R_{ni}}{N_{ni}} \frac{X_n}{B_n}$$

- Based on our theory, bilateral buyers per seller (*R/N*) varies only with bilateral search frictions (and purchases per buyer (*X/B*) depends only on the destination)
- Identifying bilateral search frictions this way, they turn out to be a huge contributor to overall trade frictions
- Estimated bilateral search frictions provide an excellent account of variation in *X/N*, while leaving a more modest role for traditional iceberg cost in explaining variation in *X* itself

Basic Facts

Table 1

$\ln N_{nF}$	$=$	$0.46 \times \ln X_n$	$+$	$0.65 \times \ln \pi_{nF}$
		(0.04)		(0.11)
$\ln R_{nF}$	$=$	$0.80 \times \ln X_n$	$+$	$1.03 \times \ln \pi_{nF}$
		(0.06)		(0.19)
$\ln \bar{b}_{nF}$	$=$	$0.34 \times \ln X_n$	$+$	$0.38 \times \ln \pi_{nF}$
		(0.03)		(0.10)

Notes: number of observations, 24;
estimated by OLS, constants suppressed.

Figure 1: French Exporters and Market Size

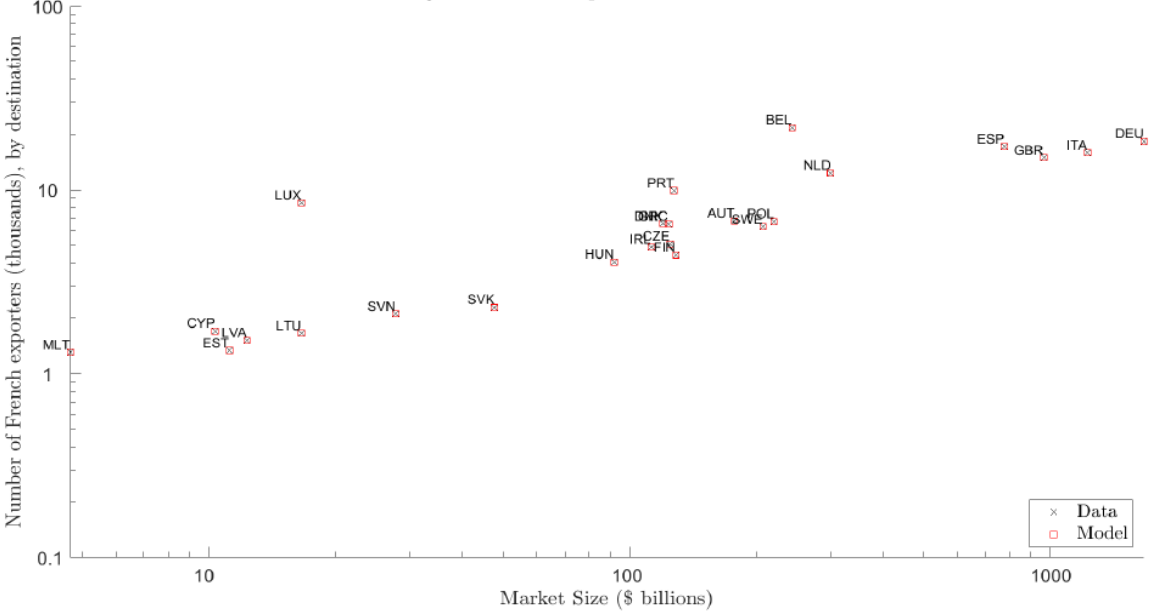


Figure 2: French Relationships and Market Size

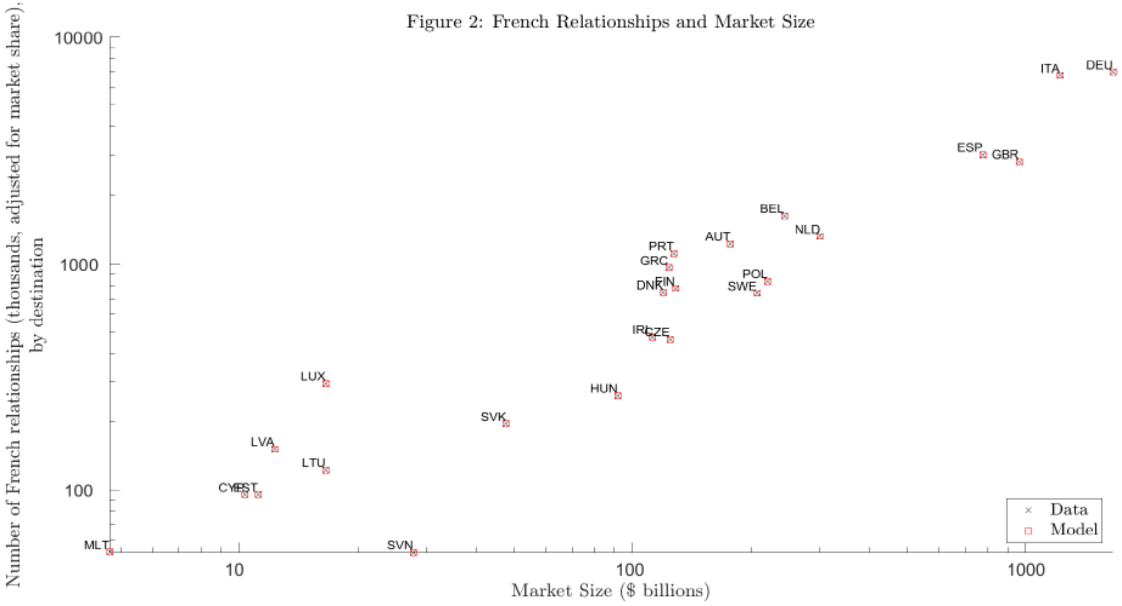


Figure 3a: Mean Number of Buyers per French Exporter and Market Size

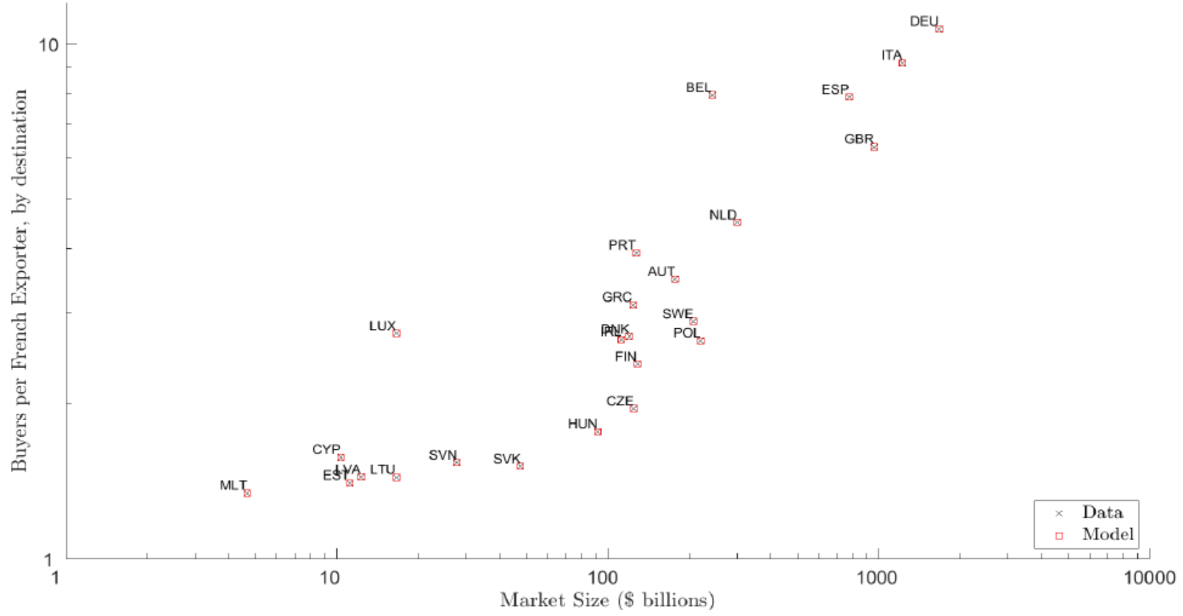


Figure 3b: Buyers per French Exporter (50^{th} and 99^{th} Percentiles) and Market Size

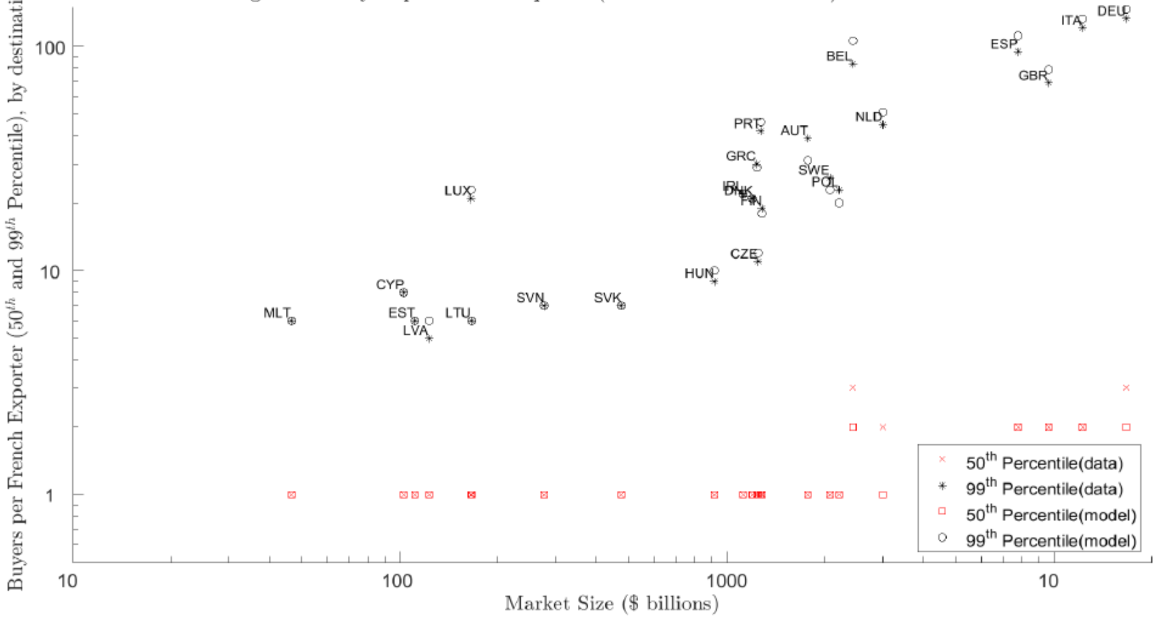


Figure 3c: Customers in Germany per French Exporter, Conditional on exporting also elsewhere

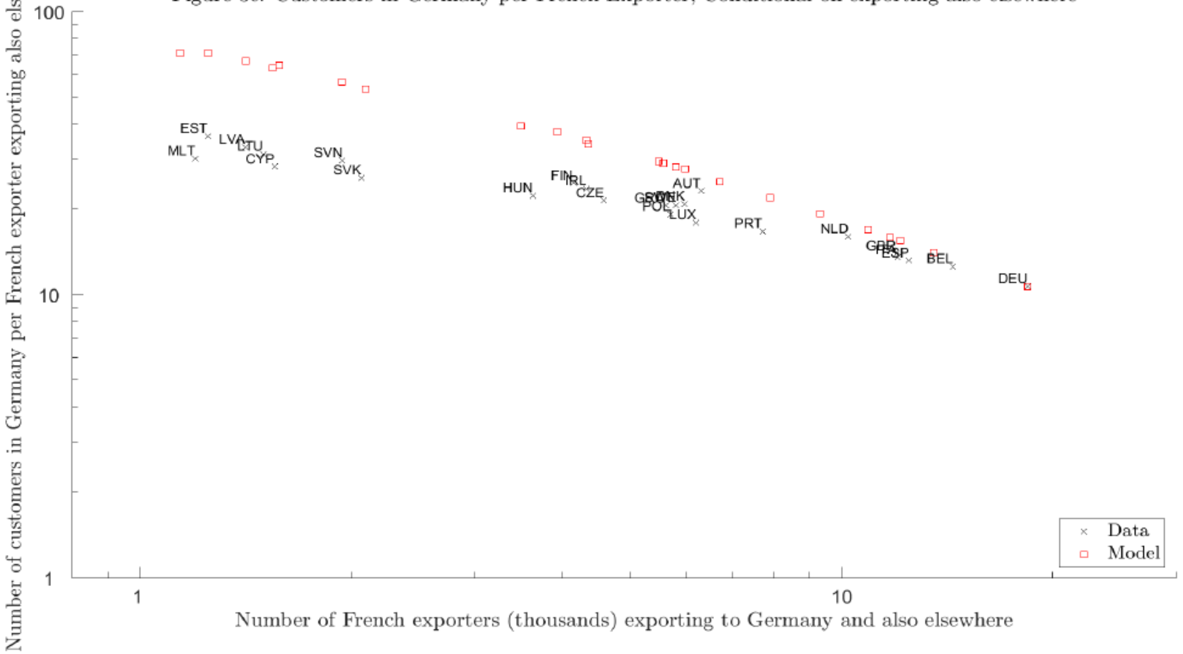


Figure 4: Sales ratio ($\bar{x}_{nF|n'}/\bar{x}_{nF}$) in Germany

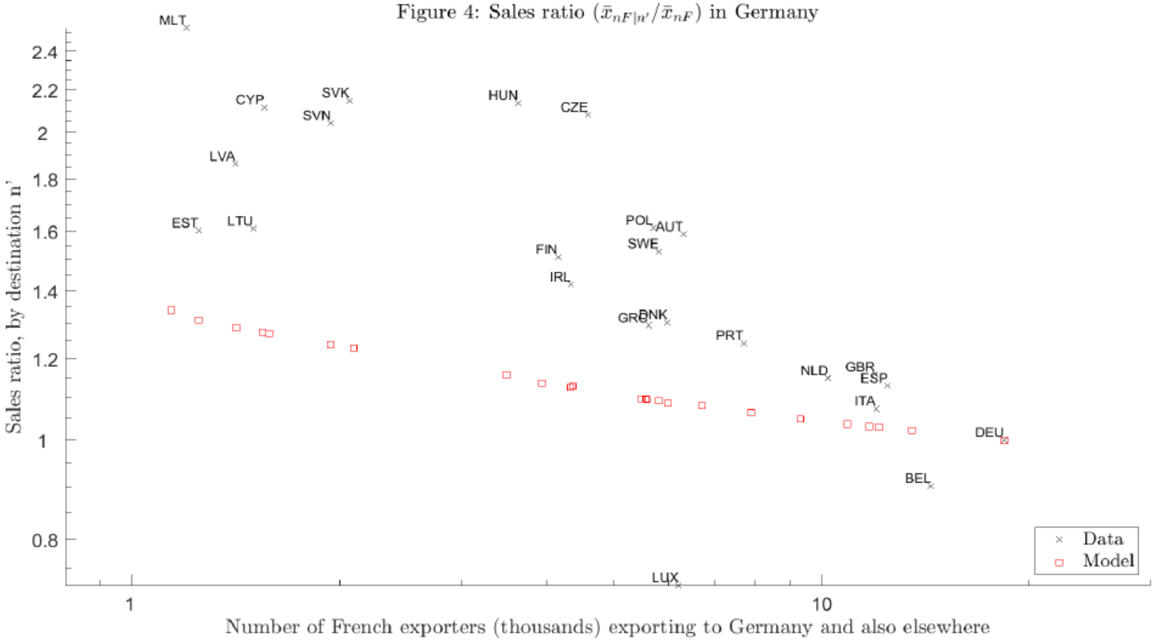


Figure 5a: Mean number of French Suppliers per buyer and Market Size

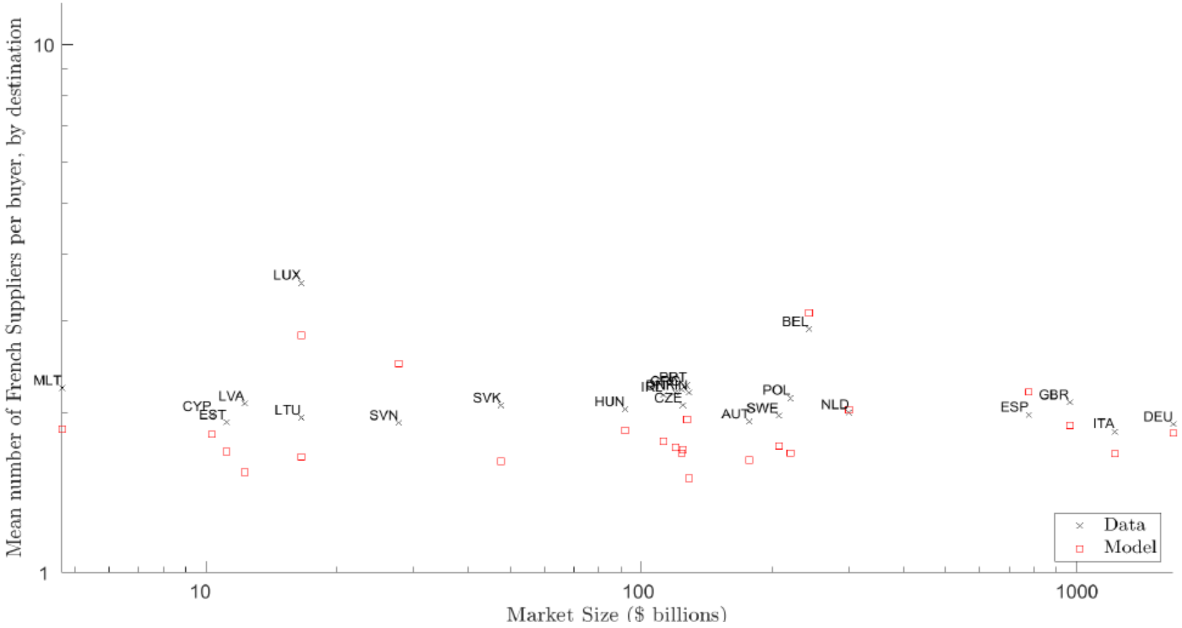


Figure 5b: French sellers per buyer (50^{th} and 99^{th} Percentiles) and Market Size

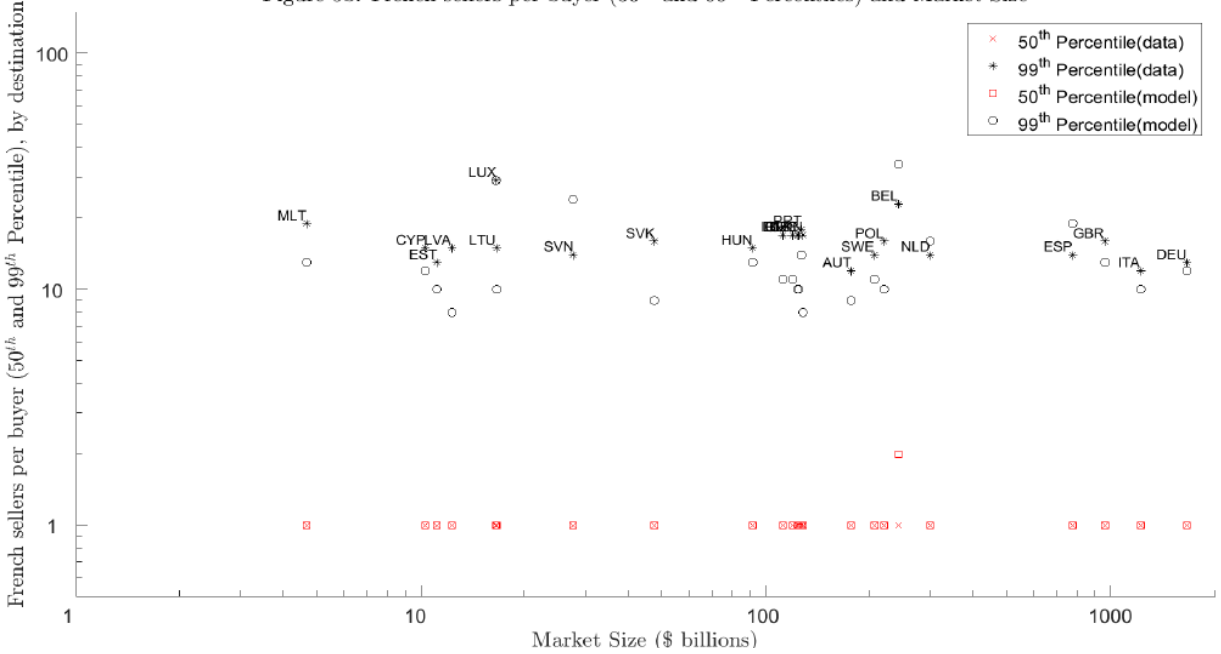


Figure 6a : Distribution of skilled labor shares in production costs in France, real vs. simulated data (2000 replications)
Quantiles used in loss function [0.05 0.1 0.15 ... 0.95 0.99]

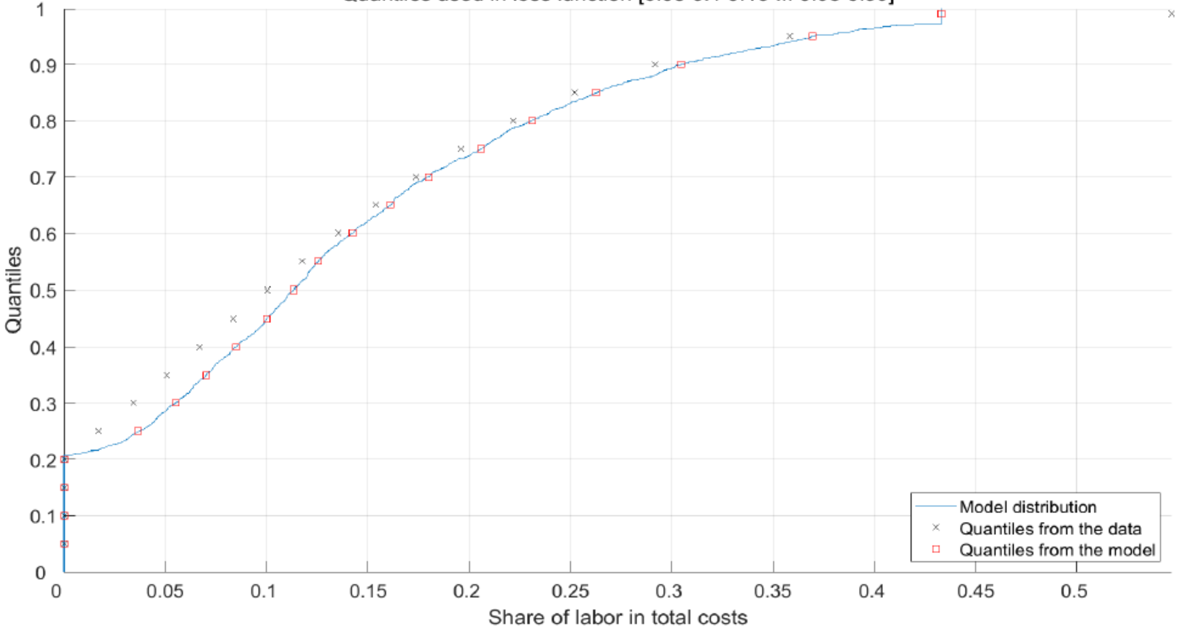
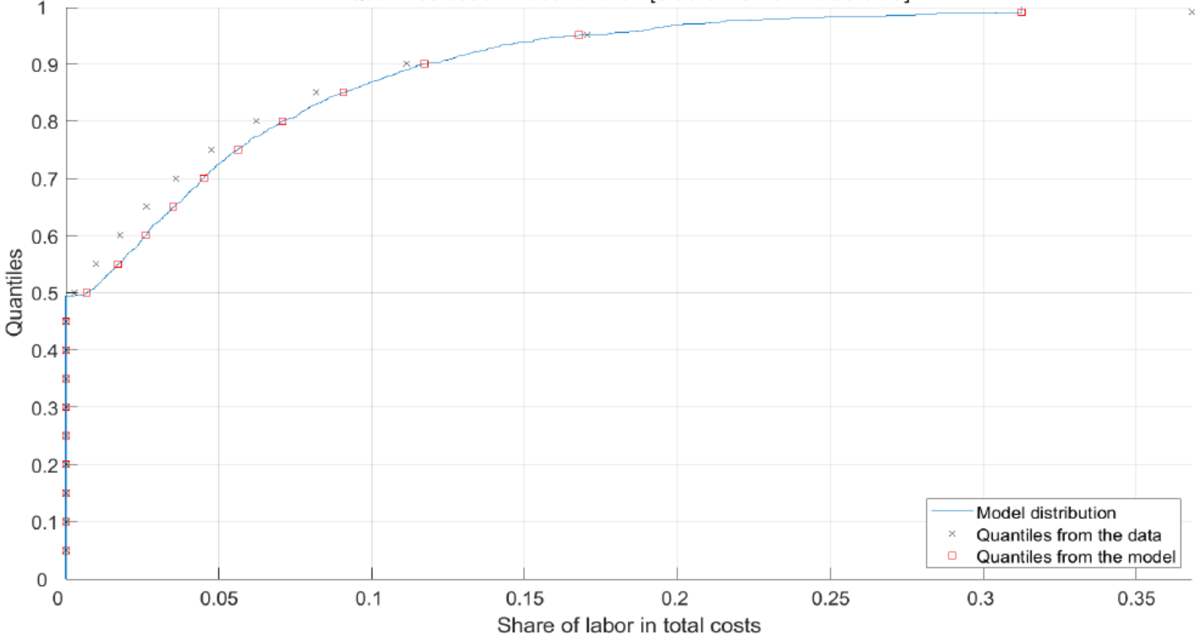


Figure 6b : Distribution of unskilled labor shares in production costs in France, real vs. simulated data (2000 replications)
Quantiles used in loss function [0.05 0.1 0.15 ... 0.95 0.99]



Theory:

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$$Q(j) = z(j) \prod_{k=0}^{K} \left(\frac{1}{\beta_k} \left(\sum_{\omega=1}^{m(j)} x_k(j,\omega)^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)} \right) \quad c_{ni}(j) = \frac{d_{ni}}{z(j)} \prod_{k=0}^{K} \left(\left(\sum_{\omega=1}^{m(j)} c_{k,i}(j,\omega)^{-(\sigma-1)} \right)^{-1/(\sigma-1)} \right)^{\beta_k}$$

$$\mu_{ni}(c) = \mu_{ii}(c/d_{ni}) = d_{ni}^{-\theta} T_i \Xi_i c^{\theta}. \quad c_{k,i}(j,\omega) = \min\left\{ \frac{w_{k,i}}{q_k(j,\omega)}, \tilde{c}_{k,i}(j,\omega) \right\}$$

$\tilde{c}_{k,i}(j,\omega)$ lowest price available

Retailers: Sell locally to local households, *z*=1, same input structure as producers

Theory:

Producers

$$Q(j) = z(j)\prod_{k=0}^{K}\left(\frac{1}{\beta_k}\left(\sum_{\omega=1}^{m(j)} x_k(j,\omega)^{(\sigma-1)/\sigma}\right)^{\sigma/(\sigma-1)}\right)^{\beta_k}$$

$$c_{k,i}(j,\omega) = \min\left\{\frac{w_{k,i}}{q_k(j,\omega)}, \tilde{c}_{k,i}(j,\omega)\right\}$$

$$c_{ni}(j) = \frac{d_{ni}}{z(j)}\prod_{k=0}^{K}\left(\left(\sum_{\omega=1}^{m(j)} c_{k,i}(j,\omega)^{-(\sigma-1)}\right)^{-1/(\sigma-1)}\right)^{\beta_k}$$

$$\mu_{ni}(c) = \mu_{ii}(c/d_{ni}) = d_{ni}^{-\theta}T_i\Xi_i c^{\theta}.$$

Retailers: Sell locally to local households, z=1, same input structure as producers

Firm-to-Firm Matching: Random, more efficient sellers meet more potential buyers locally or internationally, Poisson, hence integer number of potential buyers. For the buyer, integer number of potential sellers for a given task. A firm is active if it has at least one active buyer.

$$\lambda_{k,ni}(c) = \lambda_k\lambda_{ni}B_n^{-\varphi}S_n(c)^{-\gamma}$$

$$S_n(c) = \sum_{i'}\lambda_{ni'}\mu_{ni'}(c) = \Upsilon_n c^{\theta},$$

$$\Upsilon_n = \sum_i \lambda_{ni}d_{ni}^{-\theta}T_i\Xi_i.$$

$$e_{k,ni}(c) = \lambda_k\lambda_{ni}\frac{B_n}{K}B_n^{-\varphi}S_n(c)^{-\gamma}.$$

the latter being the mean of the Poisson distribution of the number of firm-to-firm encounters between buyers in *n* for tasks of type *k* and a given seller from *i* with unit cost exactly *c.* Solving the set of equations yield the (fixed-point) equation:

$$\Upsilon_n = \sum_i \lambda_{ni}d_{ni}^{-\theta}T_i\prod_k\left(\frac{\lambda_k}{1-\gamma}B_i^{-\varphi}\Upsilon_i^{1-\gamma} + w_{k,i}^{-\theta(1-\gamma)}\right)^{\beta_k/(1-\gamma)}$$

Aggregate equilibrium

- *Services sector*: services are sold to households as final consumption; this sector provides intermediates to the goods sector (production and retail)
- *Goods sector*: provides intermediates to the services sector via retailers
- *Labor*: all types (administrative, skilled, unskilled) are employed in both sectors and are mobile
- *Trade*: goods are traded internationally when services are local
- *Labor shares and wages*: endogenous with outsourcing; plus …

$$\frac{\beta_i^{GG}\left(1-\beta^{S,L}\alpha^S\right)}{\beta_i^{G,L}+\beta^{S,L}\beta^{GS}}w_iL_i=\sum_n \pi_{ni}\frac{\beta_n^{GG}\left(1-\beta^{S,L}\alpha^S\right)}{\beta_n^{G,L}+\beta^{S,L}\beta^{GS}}w_nL_n.$$

From the model to moments

- Relationships: $R_{ni} = \pi_{ni} p_n B_n$ with $p_n = \frac{1}{K} \sum_{k=1}^{K} \frac{\nu_{k,n}}{\Phi_{k,n}}$ the ratio being the probability of outsourcing *k*
- Elasticity of buyers per seller w.r.t. search parameter: $\frac{\partial \ln \bar{b}_{ni}}{\partial \ln \lambda_{ni}} = 1 - \frac{N_{ni}(1)}{N_{ni}} > 0.$
- Measures of importers in *n* from *i*: $F_{ni} = (1 - \Pr[s_{ni} = 0]) F_n.$ with the probability of having no supplier in *i* $\Pr[s_{ni} = 0] = \sum_m p(m) \prod_{k=1}^{K} (1 - \pi_{ni} p_{k,n})^m .$
- …

Estimation

- SMM, bootstrap for s.e. for a fraction of the model's parameters using VAT data for 2005, DADS for skills, FICUS for total production costs
- Some are calibrated to aggregate data (WIOD, 2012), in particular labor shares in the goods sector by skills, share of skills …
- … number of exporters, importers … from TEC data (OECD, EUROSTAT)

Results

Table 2: Estimation results (bilateral exporter data for 2005)

	Estimates	Standard Error		Estimates	Standard Error
γ	0.37	0.04	λ_{nF} for n=		
φ	0.23	0.03	Austria	8.08	1.49
σ	2.41	0.24	Belgium	48.45	8.09
β_s	0.43	0.02	Cyprus	1.13	0.24
λ_s	0.46	0.05	Czech Republic	2.03	0.36
λ_u	1.54	0.05	Germany	69.82	12.22
			Denmark	5.02	0.88
			Spain	70.32	12.61
p(m) for m=			Estonia	0.69	0.14
1	0.070	0.030	Finland	4.02	0.75
4	0.671	0.051	United Kingdom	32.41	5.41
16	0.206	0.043	Greece	8.37	1.46
64	0.046	0.027	Hungary	1.60	0.32
256	0.0062	0.0032	Ireland	5.51	0.97
1,024	0.000324	0.000217	Italy	76.09	15.77
4,096	0.000010756	0.000008867	Lithuania	0.70	0.17
			Luxembourg	5.96	1.32
			Latvia	0.75	0.17
			Malta	0.67	0.14
			Netherlands	18.77	3.18
			Poland	4.21	0.61
			Portugal	20.43	4.18
			Slovakia	0.87	0.18
			Slovenia	0.94	0.20
			Sweden	5.50	0.98

Notes: Parameter estimates using Simulated Method of Moments. Standard errors are calculated using a bias-corrected bootstrap (see Appendix C for details).

Results

Table 3: OLS regression: Off-diagonal elements only

	$Log(\pi_{ni})$	$Log(\pi_{ni})$	$Log(\pi_{ni})$	$Log(\pi_{ni})$	$Log(\pi_{ni})$	$Log(\pi_{ni})$	$Log(\pi_{ni})$
$Log(\lambda_{ni})$		0.59***	0.95***			0.35***	0.75***
		(0.06)	(0.04)			(0.04)	(0.07)
Log(Distance)				-1.67***	-1.08***	-1.21***	-0.33***
				(0.06)	(0.07)	(0.07)	(0.08)
Constant	-9.27***	-7.97***	-6.92***	4.26***	3.47***	1.09*	-4.97***
	(0.36)	(0.44)	(0.21)	(0.57)	(0.43)	(0.64)	(0.91)
Observations	680	680	90	680	90	680	90
Selected markets	All	All	10 largest	All	10 largest	All	10 largest
R^2	0.79	0.91	0.97	0.93	0.93	0.96	0.98

Sources: WIOD 2012. Notes: Destination and country fixed effects included. Standard errors between parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: OLS regression: Off-diagonal elements only

	$Log(\lambda_{ni})$	$Log(\lambda_{ni})$	$Log(\lambda_{ni})$	$Log(\lambda_{ni})$	$Log(\lambda_{ni})$	$Log(\lambda_{ni})$	$Log(\lambda_{ni})$
$Log(\pi_{ni})$		0.94***	0.91***			1.30***	0.89***
		(0.04)	(0.04)			(0.10)	(0.08)
Log(Distance)				-1.28***	-1.00***	0.89***	-0.03
				(0.08)	(0.08)	(0.17)	(0.10)
Constant	1.65***	5.39***	9.77***	12.04***	12.54***	1.54*	9.90***
	(0.50)	(0.16)	(0.21)	(0.74)	(0.49)	(0.89)	(0.38)
Observations	680	680	90	680	90	680	90
Selected markets	All	All	10 largest	All	10 largest	All	10 largest
R^2	0.6	0.82	0.99	0.7	0.96	0.84	0.99

Sources: WIOD 2012. Notes: Destination and country fixed effects included. Standard errors between parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Counterfactuals

- We are able to reproduce all results in EKKI, without fixed costs
- Brexit (bilateral) with changes in *d* and λ. *Boris Johnson "wins" …*
- Negative shock (Covid-style, multilateral) affecting all countries

All allow to examine the effects of trade on inequality (unskilled wages vs skilled), real and nominal effects, employment in Manufactures

Conclusion

- Capture all facts of EKKI, explain remaining puzzles (relationships vs exporters distinction), variation in *X/N* …
- Quantitative assessment of search frictions vs fixed costs
- Evidence of increasing returns in matching
- Connects trade and labor: counterfactual show how search frictions in outsourcing “nominally” benefits production workers, small and inefficient firms at the expense of costs and prices