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Lecture 8: Heterogeneous firms and the decision to export

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Introduction

- Krugman : Explains intra-industry trade in a model with imperfect competition and preference for diversity. Welfare gains through increased diversity
- Empirically successful at the aggregate level (the gravity equation)
- \bullet Less successful at the disaggregated level \Rightarrow "Zeros" in international trade
- ⇒ Mélitz (2003) proposes a simple extension of Krugman with heterogeneous firms and fixed exportation cost ⇒ Generates a gravity equation at the aggregate level and heterogeneous export behaviors. Additional welfare gains from trade through the reallocation of market shares across firms of different productivities

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The Mélitz model

See analytical details in MelitzAnalytics.pdf

Main features

Mélitz, M., 2003. "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*.

- Dynamic industry model of international trade with heterogeneous firms and imperfect competition
- Model yields a gravity type equation relating bilateral trade volumes to technology, revenues and geographic barriers
- Fixed exportation cost and increasing returns to scale imply that a minimum productivity level must be achieved for firms to enter foreign markets
- Response of bilateral trade to external shocks decomposed into two margins : intensive margin (change in the quantity each firm exports) and extensive margin (change in the number of firms that do export)

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Counterfactuals

Model can be used to answer the following questions :

- What are the welfare gains from trade? (See Lecture 4)
- What is the impact of multilateral/unilateral tariff eliminations?
- What are the relative contributions of the intensive and extensive margins in explaining aggregate trade flows?

Assumptions

- 2 symmetric countries (extended to *I* asymmetric countries in Chaney, 2008, or Helpman, Melitz & Yeaple, 2002) ⇒ Symmetry insures wage equality
- CES utility function :

$$U = \left[\int_{\omega \in \Omega} q(\omega)^{\frac{\sigma-1}{\sigma}} d\omega\right]^{\frac{\sigma}{\sigma-1}}$$

with σ the elasticity of substitution between varieties and Ω the (endogenous) mass of available goods

 \Rightarrow Dixit-Stiglitz demand functions :

$$q(\omega) = \left(\frac{p(\omega)}{P}\right)^{-\sigma} \frac{R}{P}$$

where R is the country's nominal revenue and P the ideal price index :

$$P = \left[\int_{\omega \in \Omega} p(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}$$

Assumptions (ii)

- A continuum of firms, each choosing to produce a different variety ω (with IRS, no incentive to replicate an existing variety)
- One factor of production, labor (inelastic supply $L = L^*$)
- Increasing returns to scale :

$$I(\omega) = f + \frac{q(\omega)}{\varphi(\omega)}$$

where $\varphi(\omega)$ is the firm-specific productivity level

 \Rightarrow Optimal price :

$$p(\omega) = \frac{\sigma}{\sigma - 1} \frac{w}{\varphi(\omega)}$$

where w is the wage rate (normalized to one)

 \Rightarrow Firm profit :

$$\pi(\omega) = \frac{p(\omega)q(\omega)}{\sigma} - f = \frac{R}{\sigma} \left(\frac{\sigma - 1}{\sigma} P\varphi(\omega)\right)^{\sigma - 1} - f$$

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Assumptions (iii)

- A large unbounded pool of prospective entrants into the industry
- A sunk entry cost paid prior to entry f_e
- A common distribution of productivities $g(\varphi)$ with positive support $(0,\infty)$ and continuous cumulative distribution $G(\varphi)$
- Individual productivity assumed constant over time \Rightarrow Allows to focus on steady state equilibria
- A constant death probability δ in every period (assumed independent across firms)
- Zero time discounting

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Timing

- Prospective entrants pay the sunk cost f_e if the present value of future profits is large enough
- \Rightarrow Free Entry condition (FE) :

$$v_e = p_{in} \bar{v} - f_e = 0$$

where p_{in} is the ex-ante probability of successful entry and $\bar{v} = \sum_{t=0}^{\infty} (1-\delta)^t \bar{\pi} = \frac{1}{\delta} \bar{\pi}$ is the average value of profit flows, conditional on entry

- Conditional on having paid f_e , firms draw their productivity level φ
- If $\pi(\varphi) < 0$, the firm immediately exits
- If $\pi(\varphi) \geq 0$, the firm produces each period until being hit by the death shock

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Timing (2)

 \Rightarrow Zero Cutoff Profit Condition (ZCP) :

$$\varphi^* = \inf \{ \varphi : \nu(\varphi) > 0 \} \Rightarrow \pi(\varphi^*) = 0$$

and

$$p_{in} \equiv 1 - G(\varphi^*)$$

 \Rightarrow Ex-post distribution of productivities :

$$\mu(\varphi) = \begin{cases} \frac{g(\varphi)}{1 - G(\varphi^*)} & \text{if } \varphi \ge \varphi^* \\ 0 & \text{otherwise} \end{cases}$$

 \Rightarrow Aggregate productivity level :

$$ilde{arphi}(arphi^*) = \left[rac{1}{1-G(arphi^*)}\int_{arphi^*}^{\infty}arphi^{\sigma-1}g(arphi)darphi
ight]^{rac{1}{\sigma-1}}$$

Conclusion

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Equilibrium in a closed economy

• FE and ZCP jointly determine $\bar{\pi}$ and φ^* :

$$ZCP) \qquad \bar{\pi} = f\left[\left(\frac{\tilde{\varphi}(\varphi^*)}{\varphi^*}\right)^{\sigma-1} - 1\right]$$
$$(FE) \qquad \bar{\pi} = \frac{\delta f_e}{1 - G(\varphi^*)}$$



• Equilibrium exists and is unique

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Equilibrium in a closed economy (ii)

• In a stationary equilibrium, aggregate variables are constant :

$$\underbrace{\underbrace{p_{in}M_e}_{Successful \ entrants}}_{Successful \ entrants} = \underbrace{\delta M}_{Incumbents \ exiting}$$

$$\Rightarrow \quad L_e \equiv M_e f_e = \frac{\delta M}{p_{in}} f_e = \Pi$$

$$\Rightarrow \quad R = L_p + L_e = L$$

$$\Rightarrow \quad M = \frac{R}{\bar{r}} = \frac{L}{\sigma(\bar{\pi} + f)}$$

- This completes the characterization of the unique stationary equilibrium in the closed economy
- For given $\tilde{\varphi}$ and $\tilde{\pi},$ the model behaves as in an economy with representative firms :

$$P = M^{\frac{1}{1-\sigma}} p(\tilde{\varphi}) \quad R = Mr(\tilde{\varphi}) \quad \Pi = M\pi(\tilde{\varphi})$$

International trade

- Without trade costs, international trade is equivalent to increasing L
 ⇒ No impact on individual outcomes but bigger mass of producing
 firms and welfare gain from increased variety (same as in Krugman)
- Introduce trade costs : per-unit (iceberg) trade cost τ > 1 and fixed export cost f_{ex} (per period for simplicity)
- \Rightarrow Price segmentation :

$$p_d(\varphi) = rac{\sigma}{\sigma - 1} rac{w}{\varphi}$$
 and $p_x(\varphi) = rac{\sigma}{\sigma - 1} au rac{w}{\varphi} = au p_d(\varphi)$

 \Rightarrow Given higher prices, lower revenues on exports (everything else equal) :

$$p_{d}(\varphi)q_{d}(\varphi) = R\left(\frac{\sigma}{\sigma-1}P\varphi\right)^{\sigma-1}$$

$$p_{x}(\varphi)q_{x}(\varphi) = \tau^{1-\sigma}R^{*}\left(\frac{\sigma}{\sigma-1}P^{*}\varphi\right)^{\sigma-1}$$

International trade (ii)

• Same timing but additional decision for the firm : Conditional on entering the market, staying there to produce for the domestic market once her productivity is revealed, the firm can choose to pay the additional fixed export cost. This happens if :

$$\pi_{x}(\varphi) = rac{p_{x}(\varphi)q_{x}(\varphi)}{\sigma} - f_{ex} \geq 0$$

 \Rightarrow New productivity cutoff for exports :

$$\varphi_x^* = \inf \{ \varphi : \varphi \ge \varphi^* \text{ and } \pi_x(\varphi) \ge 0 \}$$

 \Rightarrow New productivity cutoff for successful entry :

$$\begin{split} \varphi^* &= \inf \left\{ \varphi : v(\varphi) \ge 0 \right\} \\ \text{where} \quad v(\varphi) &= \max \left\{ 0; \frac{\pi(\varphi)}{\delta} \right\} \\ \text{and} \quad \pi(\varphi) &= \pi_d(\varphi) + \max\{0; \pi_x(\varphi)\} \end{split}$$

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Selection in each market

- If φ^{*}_x > φ^{*}, selection of firms into export markets : Below φ^{*}, exit / Between φ^{*} and φ^{*}_x, produce for d / above φ^{*}_x, produce for d and x
- \Rightarrow The cutoff levels thus satisfy :

$$\pi_d(\varphi^*) = 0$$
 and $\pi_x(\varphi^*_x) = 0$

This partitioning of firms by export status occurs if :

$$\tau^{\sigma-1}f_x > f$$

ie if the trade costs are large, relative to the overhead production cost

Equilibrium in open economy

• Average productivity level :

$$\begin{split} \tilde{\varphi}_{T} &= \left\{ \frac{1}{M_{T}} \left[M \tilde{\varphi}^{\sigma-1} + M_{x} \left(\frac{\tilde{\varphi}_{x}}{\tau} \right)^{\sigma-1} \right] \right\}^{\frac{1}{\sigma-1}} \\ \text{with} \quad \tilde{\varphi}(\varphi^{*}) &= \left[\frac{1}{1 - G(\varphi^{*})} \int_{\varphi^{*}}^{\infty} \varphi^{\sigma-1} g(\varphi) d\varphi \right]^{\frac{1}{\sigma-1}} \\ \text{and} \quad \tilde{\varphi}_{x}(\varphi^{*}_{x}) &= \left[\frac{1}{1 - G(\varphi^{*}_{x})} \int_{\varphi^{*}_{x}}^{\infty} \varphi^{\sigma-1} g(\varphi) d\varphi \right]^{\frac{1}{\sigma-1}} \end{split}$$

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Equilibrium in open economy (ii)

• (ZCP) and (ZE) jointly determine $\bar{\pi}$ and φ^* :

$$(ZCP) \quad \bar{\pi} = \pi_d(\tilde{\varphi}) + p_x \pi_x(\tilde{\varphi}_x)$$
with
$$\pi_d(\varphi^*) = 0 \iff \pi_d(\tilde{\varphi}) = f\left[\left(\frac{\tilde{\varphi}(\varphi^*)}{\varphi^*}\right)^{\sigma-1} - 1\right]$$

and
$$\pi_x(\varphi_x^*) = 0 \iff \pi_x(\tilde{\varphi}_x) = f_x \left[\left(\frac{\tilde{\varphi}_x(\varphi_x^*)}{\varphi_x^*} \right)^{\circ -1} - 1 \right]$$

and
$$\pi_d(\varphi^*) = 0$$
 and $\pi_x(\varphi^*_x) = 0 \iff \varphi^*_x = \varphi^* \tau \left(\frac{f_x}{f}\right)^{\frac{1}{\sigma-1}}$

and
$$p_x = \frac{1 - G(\varphi_x^*)}{1 - G(\varphi^*)}$$

(ZE) $\bar{\pi} = \frac{\sigma f_e}{1 - G(\varphi^*)}$

• Equilibrium exists and is unique

Impact of trade

Figure: Impact of trade on sales and profits



Impact of trade (ii)

International trade has an effect :

- at the extensive margin :
 - lets the most productive firms enter foreign markets : $\varphi_{\rm x}^* > \varphi^*$
 - makes the least productive domestic firms exit : $\varphi^* > \varphi^*_{\textbf{a}}$
- at the intensive margin :
 - makes the least productive that are able to remain on the market but not to export reduce their sales and profit :

 $p_d(\varphi)q_d(\varphi) < p_a(\varphi)q_a(\varphi)$

- makes the firms that are productive enough to export increase their sales :

$$p_d(\varphi)q_d(\varphi) + p_x(\varphi)q_x(\varphi) > p_a(\varphi)q_a(\varphi)$$

- the least productive of those firms however reduce their profit since the sales gain does not cover the increased fixed cost :

$$f+f_{\rm e}>f$$

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Impact of trade (iii)

- ⇒ Aggregate productivity gains through a reallocation of market shares in favor of the most productive firms
 - Notice that the exit of the least productive firms is not driven by a pro-competitive effect
 - With Dixit-Stiglitz preferences, an increase in the number of competing firms does not reduce individual sales
 - The effect comes from labor market adjustments : increased labor demand by exporting firms + more entry thanks to a higher potential returns associated with a good productive draw → ↑ real wage → forces the least productive firms to exit
 - Mélitz & Ottaviano (2008) allow for an additional pro-competitive effect of international trade (↓ of mark-ups as a result of more competition)

Aggregate trade

$$X = \int_{\varphi_X^*}^{\infty} p_X(\varphi) q_X(\varphi) Mg(\varphi) d\varphi$$

=
$$\underbrace{(1 - G(\varphi_X^*)) M}_{Mass of exporters} \underbrace{p_X(\tilde{\varphi}_X(\varphi_X^*)) q_X(\tilde{\varphi}_X(\varphi_X^*))}_{Mean exports per exporter}$$

• Assuming a Pareto distribution of productivities $(G(\varphi) = 1 - \varphi^{-\gamma})$ and an exogenous mass of firms :

$$\begin{split} \tilde{\varphi}_{X}(\varphi_{X}^{*})^{\sigma-1} &= \frac{\gamma}{\gamma-(\sigma-1)} \varphi_{X}^{* \sigma-1} \\ \varphi_{X}^{*} &= \lambda \left(\frac{f_{X}}{R^{*}}\right)^{\frac{1}{\sigma-1}} \frac{\tau}{P^{*}} \\ X &= \lambda' R^{* \frac{\gamma}{\sigma-1}} P^{* \gamma} \tau^{(1-\sigma)+(\sigma-1-\gamma)} f_{X}^{-\left[\frac{\gamma}{\sigma-1}-1\right]} \\ &= \chi' R^{* \frac{\gamma}{\sigma-1}} P^{* \gamma} \tau^{(1-\sigma)+(\sigma-1-\gamma)} f_{X}^{-\left[\frac{\gamma}{\sigma-1}-1\right]} \end{split}$$

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Aggregate trade

- Impact of trade costs on
 - the intensive margin of trade (quantity exported, conditional on exporting)
 - the extensive margin of trade (probability of exporting)
- Both variable and fixed costs of exporting matter
- In the special case of Pareto, the elasticity of trade to τ only depends on the Pareto parameter
- See details in next week's class

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Empirical evidence

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Heterogeneous behavior in export markets

Country of origin	Employ- ment premia	Value added premia	Wage premia	Capital intensity premia	Skill intensity premia
Exporters p	oremia:				
Germany	2.99 (4.39)		1.02 (0.06)		
France	2.24 (0.47)	2.68 (0.84)	1.09 (1.12)	1.49 (5.60)	
United Kingdom	1.01 (0.92)	1.29 (1.53)	1.15 (1.39)		
Italy	2.42 (2.06)	2.14 (1.78)	1.07 (1.06)	1.01 (0.45)	1.25 (1.04)
Hungary	5.31 (2.95)	13.53 (23.75)	1.44 (1.63)	0.79 (0.35)	
Belgium	9.16 (13.42)	14.80 (21.12)	1.26 (1.15)	1.04 (3.09)	
Norway	6.11 (5.59)	7.95 (7.48)	1.08 (0.68)	1.01 (0.23)	
FDI- maker	s premia:				
Germany	13.19 (2.86)				
France	18.45 (7.14)	22.68 (6.10)	1.13 (0.90)	1.52 (0.72)	
Belgium	16.45 (6.82)	24.65 (11.14)	1.53 (1.20)	1.03 (0.82)	
Norway	8.28 (4.48)	11.00 (5.41)	1.34 (0.76)	0.87 (0.13)	

Note: The table shows premia of the considered variable as the ratio of exporters over non-exporters (standard deviation ratio in brackets). France, Germany, Hungary, Italy and the United Kingdom have large firms only; Belgian and Norwegian data are exhaustive.

Source : Mayer & Ottaviano (2008) from EFIM

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Heterogeneous behavior in export markets (ii)

- Eaton, Kortum & Kramarz (2004) using French firm-level data
- In the manufacturing sector, 17.4% of firms do export. 22% of producers' sales is realized in foreign markets
- 34.5% of exporters serve only one market (Belgium most of the time). This represents 0.7% of total exports
- 1.5% of exporting firms serve more than 50 markets. This represents 52% of aggregate exports
- \Rightarrow Huge granularity in exports

Conclusion

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Heterogeneous behavior in export markets (iii)



• Granularity in the distribution of firms entering foreign markets

Heterogeneous behavior in export markets (iv)



Source : Eaton, Kortum & Kramarz (2004)

• Extensive margin and the size of the destination country :

 $\begin{array}{rrrr} \ln \# Firms_n &=& -5.061 &+& .875 & \ln F.MSh_n &+& .617 & \ln Size_n \\ (.069) & (.030) & (.021) \end{array}$

• A higher French market share in a destination reflects 88% more firms selling there and 12% more sales by firm

Structural gravity estimation

- Crozet & Koenig (2010) on French firm-level data (Customs, 1986-1992)
- Proxy variable trade costs with distance : $\tau_{ii}^{h} = \theta^{h} Dist_{ii}^{\delta^{h}}$
- Three-step method :
 - i) Probability that a firm exports $P(\varphi > \bar{\varphi}_{ij}^h)$ determines $\delta^h \gamma^h$
 - ii) Gravity equation on individual exports $x_{ij}^h(\varphi)$ determines $-\delta^h(\sigma^h-1)$
 - iii) Pareto distribution (relationship between φ and $x_{ij}^h(\varphi)$) determines $-[\gamma^h - (\sigma^h - 1)]$
- Control for firm-specific and importing country \times year-specific determinants of trade flows using FE ($j \times t$ controls for f_{ij}^h to the extent that it is common across firms)
- Since Dist_{ij} is colinear to the j × t FE, account for the location of each firm in France (adds a firm dimension) and focus on adjacent countries

Structural gravity estimation (iii)

Figure: The intensive & extensive components of the gravity equation (Crozet & Koenig, Table 2)

	All fir	ms	Single-region firms			
	> 20 emp	loyees	> 20 employees			
	(1)	(2)	(3)	(4)		
	Average	Number of	Average	Number of		
	Shipment	Shipments	Shipment	Shipments		
	$\ln (M_{kjt}/N_{kjt})$	$\ln (N_{kjt})$	$\ln (M_{kjt}/N_{kjt})$	$\ln (N_{kjt})$		
$\ln (GDP_{kj})$	0.461^{a}	0.417^{a}	0.421^{a}	0.417^{a}		
	(0.007)	(0.007)	(0.007)	(0.008)		
. (51)	0.0084	0 1100	0.0000	0.1884		
$\ln (Dist_j)$	-0.325 ^a	-0.446 ^a	-0.363"	-0.475"		
	(0.013)	(0.009)	(0.012)	(0.009)		
$Contig_j$	-0.064^{c}	-0.007	0.002	0.190^{a}		
	(0.035)	(0.032)	(0.038)	(0.036)		
Colony _i	0.100^{a}	0.466^{a}	0.141^{a}	0.442^{a}		
.,	(0.032)	(0.025)	(0.035)	(0.027)		
French	0.213^{a}	0.991 ^a	0.188 ^a	1.015^{a}		
	(0.029)	(0.028)	(0.032)	(0.028)		
N	23553	23553	23553	23553		
R^2	0.480	0.591	0.396	0.569		

Note: These are OLS estimates with year and industry dummies. Robust standard errors in parentheses with ^a, ^b and ^c denoting significance at the 1%, 5% and 10% level respectively.

• Extensive margin accounts for 57% of the distance effect

Structural gravity estimation (iii)

Figure: By-sector results (Crozet & Koenig, Table 3)

1		(1)	(2)	(3)	(4)	(5)	(6)
		P[Export > 0]	Export value	Pareto#			
Industry Code		$-\delta\gamma$	$-\delta(\sigma - 1)$	$-[\gamma - (\sigma - 1)]$	γ	σ	δ
Iron and steel 10		-5.51 ^a	-1.71 ^a	-1.36	1.98	1.62	2.78
Steel processing	11	-1.5 ^a	-0.99 ^a	-1.74	5.1	4.36	0.29
Metallurgy	13	-2.14 ^a	-0.73 ^a	-1.85	2.82	1.97	0.76
Minerals	14	-2.98 ^a	-0.91 ^a	-2.86	4.11	2.25	0.72
Ceramic and building mat.	15	-2.63 ^a	-0.76 ^a	-1.97	2.76	1.79	0.95
Glass	16	-2.33 ^a	-0.58 ^a	-2.13	2.84	1.7	0.82
Chemicals	17	-1.81 ^a	-0.76 ⁿ	-1.09	1.89	1.8	0.95
Speciality chemicals	18	-0.97^{a}	-0.34^{a}	-1.39	2.13	1.74	0.46
Pharmaceuticals	19	-1.19 ^a	-0.14	-1.4			
Foundry	20	-1.72 ^a	-0.85 ^a	-2.37	4.68	3.31	0.37
Metal work	21	-1.19 ^a	-0.36 ^a	-2.43	3.48	2.05	0.34
Agricultural machines	22	-2.06 ^a	-0.57 ⁿ	-2.39	3.31	1.92	0.62
Machine tools	23	-1.29 ^a	-0.48 ^a	-2.47	3.92	2.45	0.33
Industrial equipment	24	-1.25 ^a	-0.48 ^a	-1.97	3.21	2.24	0.39
Mining/civil egnring eqpmt	25	-1.37 ^a	-0.46 ^a	-1.9	2.86	1.96	0.48
Office equipment	27	-0.52 ^a	-1.02	-1.57			
Electrical equipment	28	-0.8 ^a	-0.14	-2.34			
Electronical equipment	29	-0.77 ^a	-0.24 ^a	-1.63	2.34	1.71	0.33
Domestic equipment	30	-0.94 ^a	-0.14 ^a	-2.13	2.51	1.37	0.38
Transport equipment	31	-1.4 ^a	-0.55 ^a	-2.23	3.69	2.46	0.38
Ship building	32	-3.69 ^a	-2.67^{a}	-1.52	5.53	5.01	0.67
Aeronautical building	33	-0.78^{a}	-0.13	-3.27			
Precision instruments	34	-1.07 ^a	0.08	-1.63			
Textile	44	-1.17 ^a	-0.3 ^a	-1.37	1.84	1.47	0.64
Leather products	45	-1.24 ^a	-0.44 ^a	-1.63	2.53	1.9	0.49
Shoe industry	46	-0.42 ^a	-0.29 ^a	-2.3	7.31	6.01	0.06
Garment industry	47	-0.33 ^a	0.13	-1.04			
Mechanical woodwork	48	-2.14 ^a	-0.2 ^a	-1.5	1.65	1.15	1.29
Furniture	49	-1.43 ^a	-0.37^{a}	-2.25	3.04	1.79	0.47
Paper & Cardboard 50		-1.45 ^a	-0.76 ^a	-1.76	3.71	2.95	0.39
Printing and editing 51		-1.4 ^a	-0.7 ^a	-1.24	2.46	2.22	0.57
Rubber	52	-1.26 ^a	-0.8 ^a	-2.52	6.93	5.41	0.18
Plastic processing	53	-1.24 ^a	-0.51 ^a	-1.6	2.7	2.11	0.46
Miscellaneous	54	-0.91 ^a	-0.33 ^a	-1.22	1.92	1.7	0.47
Trade-weighted mean		-1.41	-0.53	-1.86	3.09	2.25	0.58

^a, ^b and ^c denote significance at the 1%, 5% and 10% level respectively. [#]: All coefficients in this

column are significant at the 1% level. Estimations include the contiguity variable.

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Structural gravity estimation (iv)

- Distance has a significant effect on export probability for all industries and on export volume for all but 6 industries
- Results consistent with theory : $\hat{\sigma}^h > 1$ and $\hat{\gamma}^h > \hat{\sigma}^h 1$
- On average, the extensive margin accounts for 62% of the overall effect of distance or trade barriers on trade
- Estimated on firms with more than 20 employees → Right tail of the distribution on which Pareto is more likely to hold (Axtell, 2001)

A structural estimation of Melitz

- Eaton, Kortum & Kramarz (2011)
- Estimate a model of firm heterogeneity and export participation (\approx Melitz-Chaney) to match moments of the French data using the method of simulated moments.
- Over half the variation across firms in market entry can be attributed to efficiency heterogeneity
- But basic model fails in different aspects : (i) Firms do not enter markets according to an exact hierarchy. (ii) Their sales where they do enter deviate from the exact correlations the basic model insists on. (iii) Firms that export sell too much in France. (iv) In the typical destination, there are too many firms selling small amounts.
- $\Rightarrow\,$ Augment the model with two additional sources of heterogeneity : market and firm-specific heterogeneity in entry costs and demand

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A structural estimation of Melitz (ii)

Assumptions :

- i) Melitz-Chaney (ie Melitz + exogenous mass of entrants + Pareto distribution of productivities, θ the heterogeneity parameter)
- ii) Fixed export cost ("Cost to acquire consumers", Arkolakis, 2010) has a firm \times destination random coefficient :

$$f_{ij}(\varphi) = \varepsilon_j(\varphi) E_{ij} M(f)$$

where f is the share of the market's consumers reached, and

$$M(f) = \frac{1 - (1 - f)^{1 - 1/\lambda}}{1 - 1/\lambda}$$

where $\lambda > 0$ reflects the increasing cost of reaching a larger fraction of consumers

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A structural estimation of Melitz (iii)

iii) Dixit-Stiglitz demand function that depends on the share f of consumers reached and a market×destination-specific demand shock :

$$X_j(\varphi) = \alpha_j(\varphi) f X_j \left(\frac{p_j(\varphi)}{P_j} \right)^{1-\alpha}$$

• Assume $\ln \alpha_j(\varphi)$ and $\ln \eta_j(\varphi) \equiv \ln \alpha_j(\varphi) - \ln \varepsilon_j(\varphi)$ are normally distributed with zero means, variance σ_{α}^2 and σ_{n}^2 and correlation ρ

$$ightarrow$$
 Model reduces to 5 parameters $(heta,\lambda,\sigma_{lpha}^2,\sigma_{\eta}^2,
ho)$

Data :

- Sales of French manufacturing firms in 113 destinations, including France
- Restricted to firms selling in France and at least one market

A structural estimation of Melitz (iv)

Moments matched :

- Proportion of simulated exporters selling to each possible combination of the seven most popular export destinations
- For firms selling in each possible export destination, q^{th} percentile sales in that market (i.e., level of sales such that a fraction q of firms selling in n sells less than q% of firms, q = 50, 75, 95)
- For firms selling in each possible export destination, q^{th} percentile sales in France (i.e., level of sales such that a fraction q of firms selling in n sells less than q% of firms (q = 50, 75, 95) in France)
- For firms selling in each possible export destination, q^{th} percentile ratio of sales in the destination to sales in France (q = 50, 75, 95)
- \Rightarrow Minimize the distance between observed and simulated moments

A structural estimation of Melitz (v)

Table: Results (EKK, 2011, p. 1479)

$\tilde{\theta}$	λ	σ_{lpha}	σ_{η}	ρ
2.46	0.91	1.69	0.34	-0.65
(0.10)	(0.12)	(0.03)	(0.01)	(0.03)

Bootstrapped standard errors in parentheses

- $\tilde{\theta}=$ 2.46 implies that fixed costs dissipate 59% of gross profits in any destination \rightarrow This is huge
- $\sigma_{\alpha} = 1.69$ implies enormous idiosyncratic variation in a firm's sales across destinations (\neq Melitz)
- $\sigma_{\eta} = .34$ means much less variation in the entry shock
- $\rho < 0$ reflects high variation of sales in a market
- λ close to 1 means that a firm that is close to the entry cutoff incurs a very small entry cost, which can explains why a lot of firms sells very little in some export markets (≠ Melitz)

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A structural estimation of Melitz (vi)

Model fit : Compare predictions of the model with data on moments that are not used in the estimation procedure :

- Export probability
- Hierarchy in entry into the most popular markets
- Distribution of sales in a market (mean and percentiles)
- Distribution of sales in France, conditional on market entry
- Export intensity

A structural estimation of Melitz (vii)

Table: Model versus data (EKK, 2011, Figure 5)



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Conclusion

- An elegant model introducing heterogeneity in an international trade model with imperfect competition
- Rich predictions about trade adjustments, at the intensive and extensive margin
- Reproduces a number of stylized facts about firms in international markets
- Tractability comes at the cost of a number of (strong) simplifying assumptions : No dynamics, Pareto distribution of firms, Homogenous fixed entry cost across firms...
- Eaton, Kortum & Kramarz (2011) : Model needs to be augmented with market-specific "shocks" on trade costs to fit the data

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