Granular Comparative Advantage

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Granularity

- Granularity = heavy-tailed distribution + discreteness
  - Canonical example: power law distribution, with shape $\mu < 2$
- Properties (vs Gaussian world): a single draw can shape $\sum_{n=1}^{N} X_n$
  - Events much larger than the mean happen "frequently"
  - Infinite variance for $\mu < 2$, even infinite mean for $\mu < 1$
  - Average can differ from expected value even for large N
- Most common application: aggregate fluctuations
- Applications to trade is natural:
  - Granularity of firms within sectors
  - Few firms may shape country-sector specialization:

    $\longrightarrow$ **Granular CA** vs **Fundamental CA**

Exports are Granular!

- Exporter "superstars" (Freund and Pierola, 2013)
  Across 32 developing countries:
  - Top firm: 15% of total exports of a country on average
- French manufacturing - aggregate level
  - Top firm: 7% of exports
- French manufacturing - sector level by level of aggregation
  - Top firm: 18% sectoral exports on average, 23 sectors
  - Top firm: 26% sectoral exports on average, 103 sectors
  - Top firm: 37% sectoral exports on average, 316 sectors

Trade Models

- Trade models acknowledge fat-tailed-ness but not discreteness of heterogeneous firm distributions
  - Emphasis on firms, but each firm is infinitesimal
  - and Law of Large Number applies
- Exceptions:
  - Eaton Kortum Sotelo (2010)
    - One sector model
    - Main application: discreteness explains zeros
  - Literature on markups (Atkeson and Burstein, 2008)
- Focus here: can granularity help explain trade patterns?
  - Relaxing Melitz-type LLN within sectors
  - A single firm can shape sectoral outcomes
  - Realized average is different from mean distribution

This paper

- A trade model with
  - firm heterogeneity
  - sector-level comparative advantage
  - granularity (relaxing the LLN assumption)
- The model matches the data very well
- Explore the implications of the calibrated model
- Next steps:
  - take the model to the data
  - study counterfactuals
    - persistence of comparative advantage
    - adjustment to a trade liberalization
    - response to a displacement of a big firm

Why do we care?

- Fundamental question: which goods do countries trade?
- Is there a difference between FCA and GCA?
- Does it improve our predictive ability?
- Does it give different answers to counterfactuals?

Preliminary Findings

1. The model is very successful at matching a number of across- and within-sector regularities

2. Top export sectors tend to be driven by granularity forces rather than sector-level comparative advantage
   - a possible explanation for the dynamics of CA (Hanson et al. 2014)

3. Moments of distribution of firms within sectors (e.g. size of top firm relative to median firm) have an explanatory power for trade
   - a route to empirical identification of GCA vs FCA

4. Accounting for granularity has implications for counterfactual analysis (e.g., dynamics of CA)

Model

- General structure of the model
  - 2 countries Home and Foreign (L, L^*)
  - Continuum of sectors z; Cobb-Douglas across sectors
  - Sector vary in their comparative advantage $\frac{T(z)}{T^*(z)}$
  - Within each sector: discrete Melitz/EKS

- Demand:
  - Aggregate

$$Q = \exp\left\{\int_0^1 \eta(z) \log Q(z)\, dz\right\}$$

  - Within sector z

$$Q(z) = \left[\sum_{i=1}^{N(z)} q_{i,z}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$

Production

- Productivity draws:
  - $N_\varphi \sim$ Poisson $(T(z)\varphi^{-\theta})$
  - N_φ firms have productivity $\tilde{\varphi} \geq \varphi$
  - $T(z)$ governs average firm productivity, θ dispersion
  - Distribution of firm productivity is Pareto

- Costs of production:
  - Marginal cost of producing q: wq/φ
  - Fixed cost of serving Home: F units of home labor (resp. F^* units of foreign labor to serve Foreign)
  - Iceberg trade cost τ

Competition

- Constant markups - monopolistic competition
  - Simplification (for now)
  - Quantitatively relevant approximation under Bertrand competition
- Aggregate price index and wage taken as given by firms
  - Consistent with assumption of continuum of sectors (vs EKS)

Entry

- Sequential entry, in increasing order of unit cost
  $c_1 < c_2 < ... < c_\infty$, where c_i is i^{th} unit cost of serving Home:

$$c_i = \frac{w}{\varphi_i} \text{ if } i^{th} \text{ firm is from H , } c_i = \frac{\tau w^*}{\varphi_i^*} \text{ if from F}$$

- Firm i's profit in Home:

$$\Pi_i = \frac{1}{\sigma} s_i Y - wF$$

- Market share

$$s_i = \frac{c_i^{1-\sigma}}{\sum c_k^{1-\sigma}}$$

General equilibrium

- Fixed point procedure: get Y, Y^*, w^* and K, K^* (number of firms entering each market)
  1. Fix pool of ordered productivity draws once and for all
  2. For a given Y, Y^*, w^*
  3. Compute c_i sequence
  4. Compute $s_i^L = \frac{c_i^{1-\sigma}}{\sum_1^i c_k^{1-\sigma}}$ market share of the last if i firms enter
  5. K is last firm with positive profits $\Pi_K^L \geq 0$, $\Pi_{K+1}^L < 0$
  6. Find Y, Y^*, w^* using goods and labor market clearing
  7. Iterate until Y, Y^*, w^* match with step 2

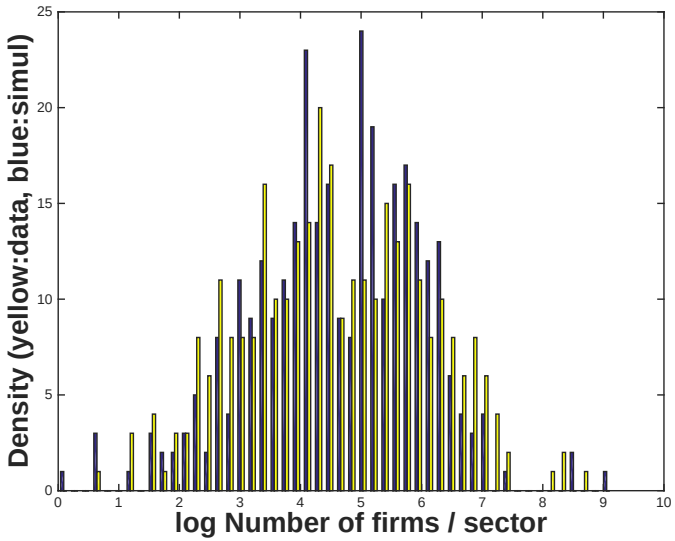
A first pass at calibration

- French firms
- Data used: firm-level domestic sales, export sales
- 316 4-digit manufacturing industries

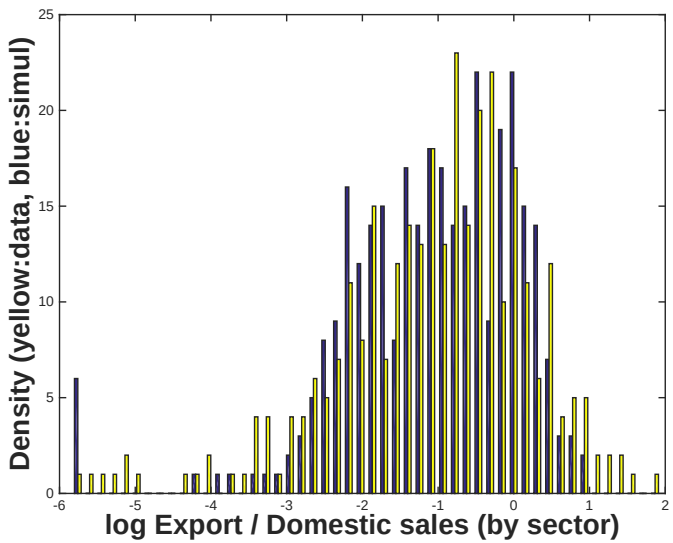
Parameter	Value	Moment
Fixed cost	$F = 1.2 \cdot 10^{-5}$	Average N(z)
Productivity dispersion	$\theta = 6$	Dispersion of exports $X(z)$
Elasticity of substitution	$\sigma = 7.5$	Average Pareto Shape, $\frac{\theta}{\sigma-1} = 0.92$
Iceberg trade costs	$\tau = 1.3$	Aggregate export share
Relative country size	$L^*/L = 2.5$	Export>Domestic sales
Slope of FCA	$T(z)/T^*(z) \in [1/5, 5]$	$R^2 = 0.45$ of exports in Chor
Cobb-Douglas shares	$\eta(z) \perp T(z)$	Shares in the data

Model fit

Distribution of number of firms
(across sectors)



Distribution of export/domestic sales
(across sector)



- Decomposition of domestic sales

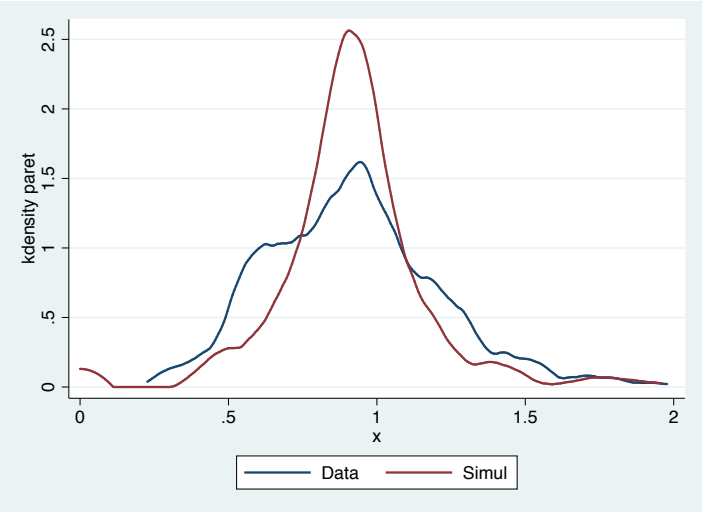
$lnX(z) =$	$ln\bar{x}(z)+$	$lnN(z)$
Data	.70	.30
Simul	.70	.30

- Decomposition of export sales

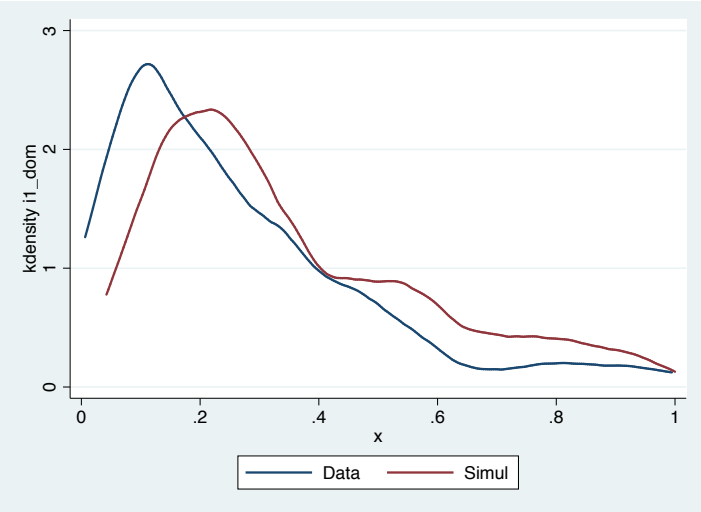
$lnX(z) =$	$ln\bar{x}(z)+$	$lnN(z)$
Data	.72	.29
Simul	.75	.26

Model fit — granularity

Distribution of Pareto shapes
(across sectors)



Distribution of top firm market shares
(across sectors)



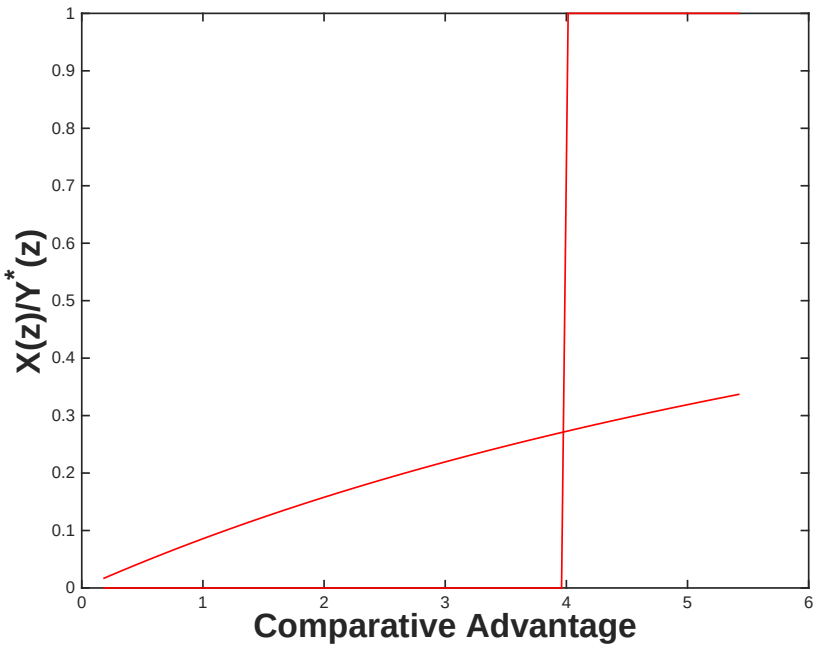
- Market share of first domestic firm

$\log s_{(1)}(z) =$	$\beta \log N(z) + \epsilon(z)$
Data	$-.10$
Simul	$-.07$

Exports and Comparative Advantage

- **DFS** (Ricardian CA) across sectors and **Melitz** within sectors:

$$\frac{X(z)}{Y^*(z)} = \frac{1}{1 + \frac{T^*(z)}{T(z)} \tau^\theta \omega^\kappa}$$

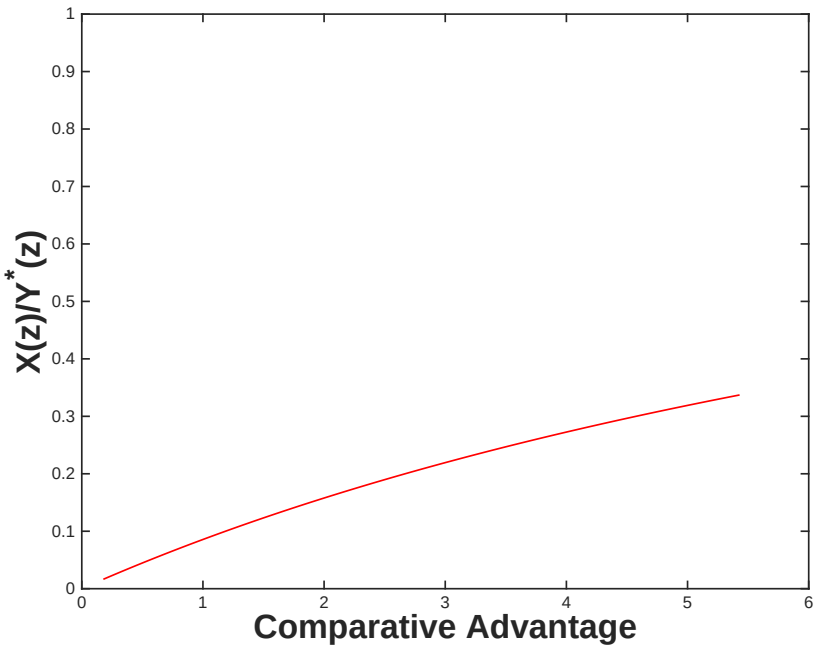


- Converges to DFS when $\sigma, \theta \to \infty$ and $f_x, f_d \to 0$
- Note: $\kappa = \frac{\sigma\theta}{\sigma - 1} - 1$. If $\frac{\theta}{\sigma - 1} = 1$ then $\kappa = \theta$. Formula applies when $f_x = f_d$.

Exports and Comparative Advantage

- **DFS** (Ricardian CA) across sectors and **EKS** within sectors:

$$E\left\{\frac{X(z)}{Y^*(Z)}\right\} = \frac{1}{1+\frac{T^*(z)}{T(z)}\,\tau^{\theta}\,\omega^{\theta}},$$



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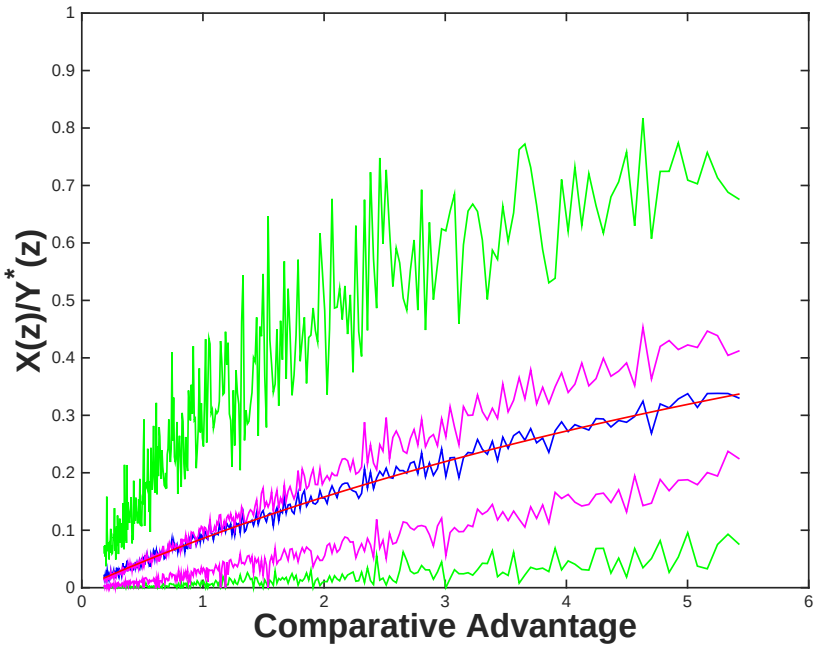
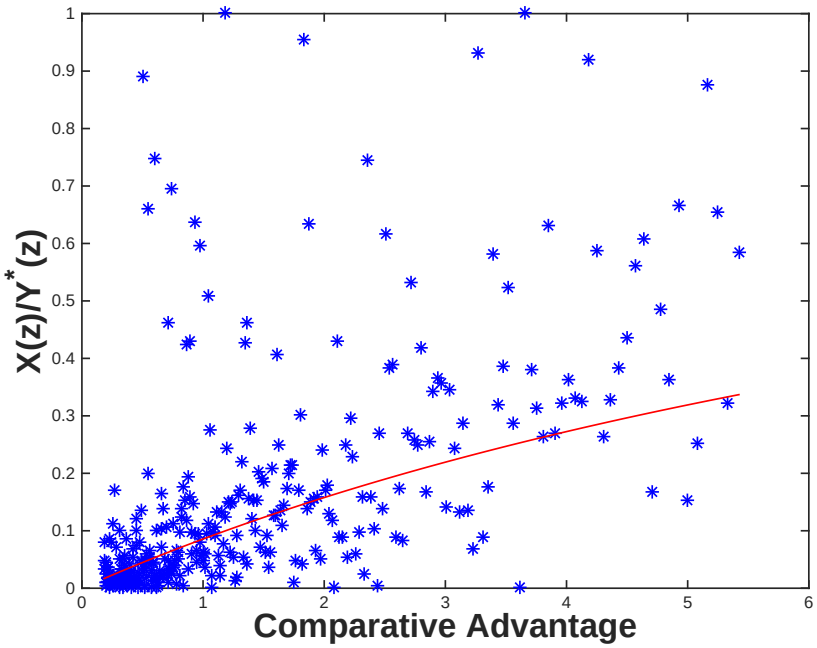


- 200 simulations, Blue: Average Exports, Pink: p25, p75, Green: p5, p95.

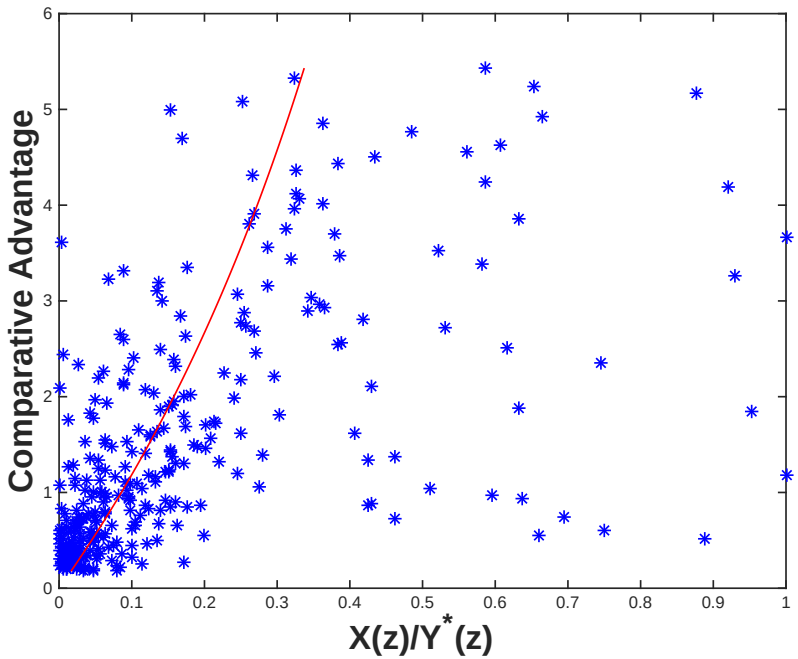
Exports and Comparative Advantage

Exports vs CA



- Relationship is very noisy

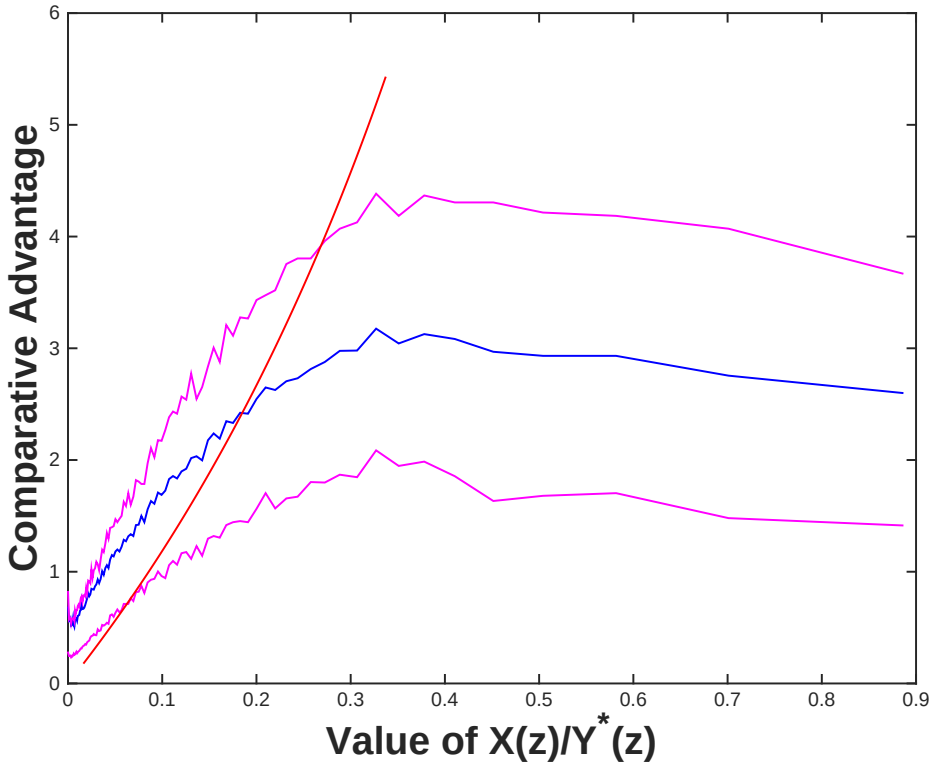
CA vs Exports



- Reverse axis
- Top export sectors are not systematically driven by CA

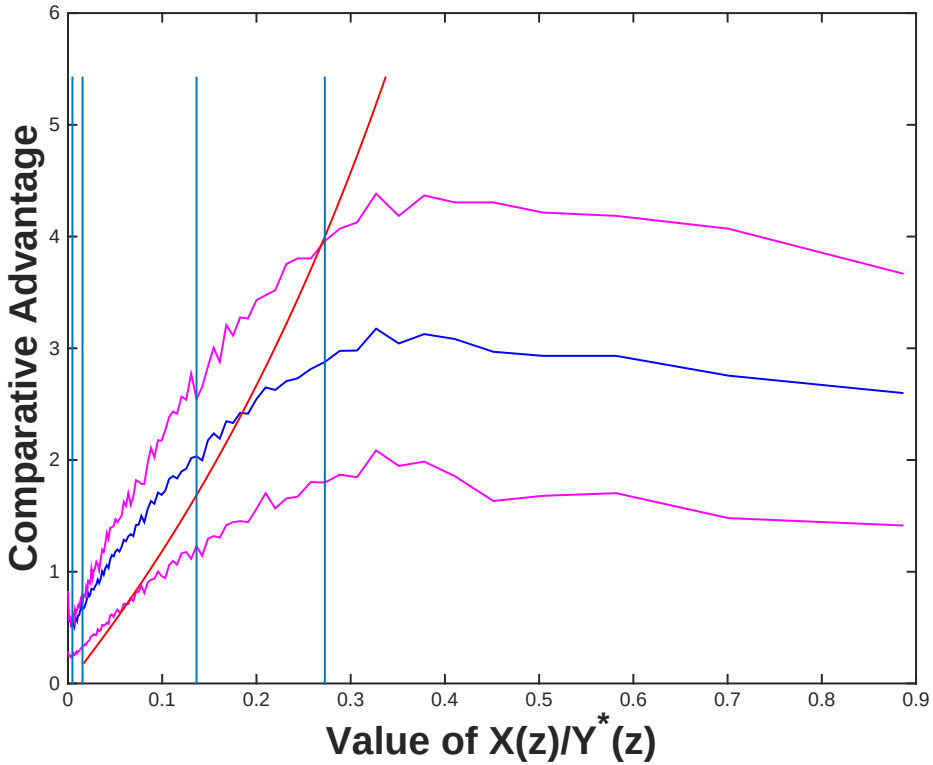
Exports and Comparative Advantage

- 200 simulations



Exports and Comparative Advantage

- 200 simulations



- Among top 10% export sectors, relative export intensity is not driven by comparative advantage ▸ Smaller R^2 ▸ Thinner Tails

Granularity and Comparative Advantage

- Explore properties of simulated model
- Do features of the within-sector distribution predict sectoral trade?
  - e.g., skewness of sales, role of the top firm

Controlling for comparative advantage

	log export / domestic sales					
	(1)	(2)	(3)	(4)	(5)	(6)
log Comp. Advantage	0.785**	0.757**	0.811**	0.754**	0.813**	0.750**
Dom. M.S. of 1st dom firm		2.191**				-0.974
Dom. M.S. of top 2-3 dom firm			-0.611			0.392
log Ratio 1/ Median				0.397**		0.591**
Dom. M.S. of median firm					1.950**	3.935**
log n domestic firm		0.098**	-0.119**	-0.421**	-0.069	-0.574**
R-squared	0.45	0.68	0.48	0.71	0.50	0.77

- Relative size of first domestic firm is a strong predictor of export in the calibrated model
- Next steps: explore further the link between exports and measures of granularity/skewness (data)

Granularity and Comparative Advantage

- Explore properties of simulated model
- Do features of the within-sector distribution predict sectoral trade?
  - e.g., skewness of sales, role of the top firm

Without comparative advantage control

	log export / domestic sales				
	(1)	(2)	(3)	(4)	(5)
Dom. M.S. of 1st dom firm	2.519**				-0.998
Dom. M.S. of top 2-3 dom firm		-0.954			0.240
log Ratio 1/ Median			0.452**		0.649**
Dom. M.S. of median firm				2.007**	4.143**
log n domestic firm	0.203**	-0.044	-0.390**	0.013	-0.546**
R-squared	0.28	0.01	0.31	0.02	0.37

- Relative size of first domestic firm is a strong predictor of export in the calibrated model
- Next steps: explore further the link between exports and measures of granularity/skewness (data)

Evolution of Comparative Advantage

- "The Dynamics of Comparative Advantage" (Hanson et al. 2014):
  1. Hyperspecialization of exports
     - Top sector out of 135 : 21% total exports; Top 3: 45%
  2. High Turnover
     - A sector in the top 5% has only 40% chance to still be in the top 5% a decade later
- Simulated model:
  1. Top 3 sectors out of 316: 26%; Top 9: 43%
  2. A sector in the top 5% in a given simulation has only 15% chance to be in the top 5% in another simulation withh all new draws (lower bound)
- Potential to match the facts with some persistence in draws
- Next steps: explore the dynamic version of the granular model

Next steps

- Data: exploration of model implications
- Theory: Dynamics?
- Counterfactual analysis:
  - remove comparative advantage
  - remove top firm
  - impact of trade liberalization
  - entry and exit
- Quantify the contribution of granularity in explaining trade flows at different levels of aggregation

APPENDIX

Robustness: higher R^2 of CA

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- Increase CA across sectors so that the $R^2 = 0.65$

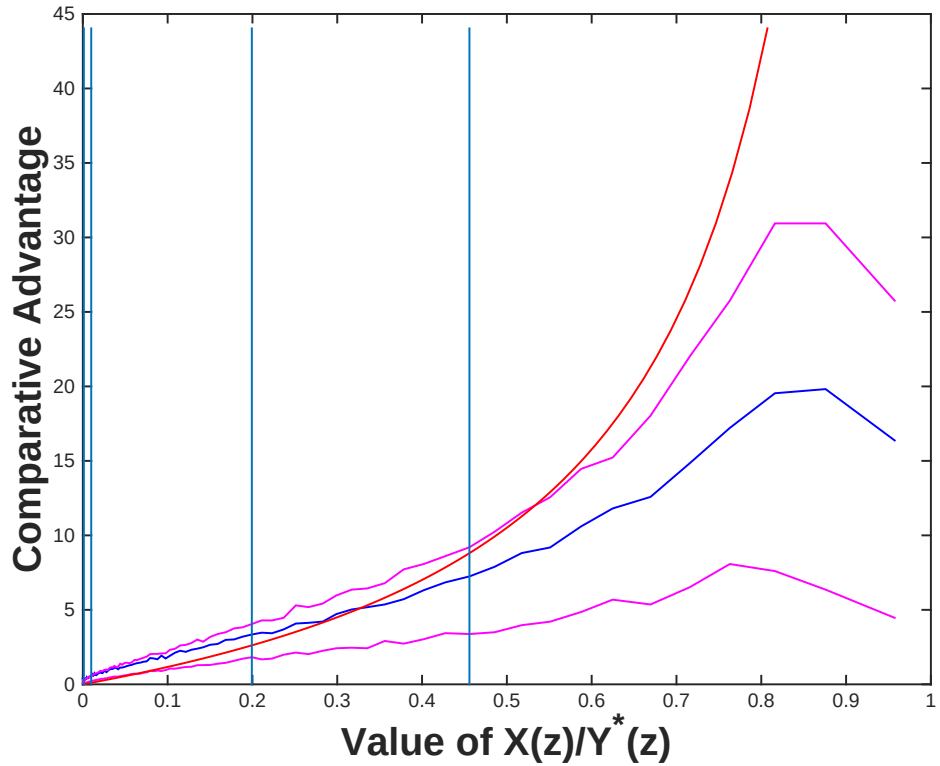

Figure : $\sigma = 7.5$, $\theta = 6$, higher R-squared of CA

Robustness: higher R^2 of CA

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- Increase CA across sectors so that the $R^2 = 0.65$

	log export / domestic sales					
	(1)	(2)	(3)	(4)	(5)	(6)
log Comp. Advantage	0.676**	0.673**	0.705**	0.670**	0.704**	0.664**
Dom. M.S. of 1st dom firm		1.992**				-0.742
Dom. M.S. of top 2-3 dom firm			-0.548			0.531
log Ratio 1/ Median				0.361**		0.521**
Dom. M.S. of median firm					1.884**	3.689**
log n domestic firm		0.072**	-0.128**	-0.402**	-0.078**	-0.507**
R-squared	0.65	0.78	0.67	0.80	0.68	0.83

- Results are a bit compressed, but qualitatively similar

Robustness: thinner Pareto tails

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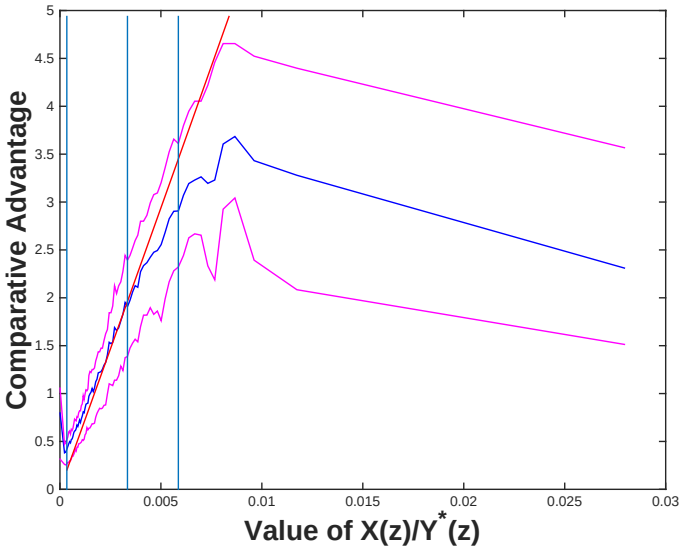
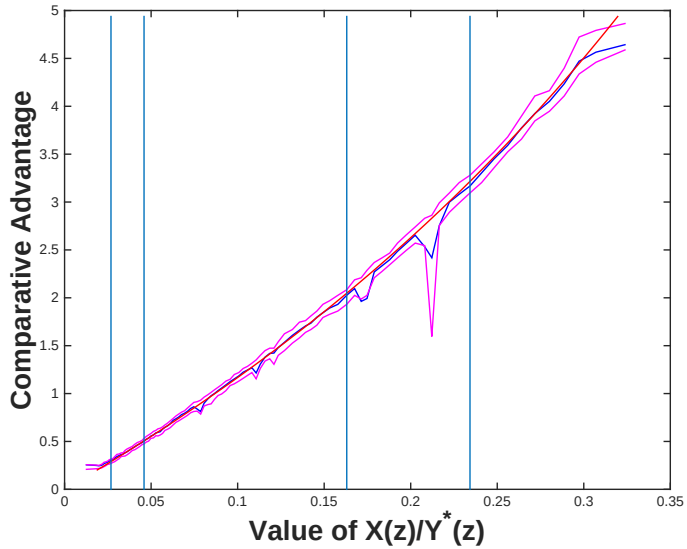
- Thinner tail of firm sizes: $\frac{\theta}{\sigma-1} = 2.5$ (vs 0.92 in the baseline)

Figure : $\sigma = 7.5$, $\theta = 16.5$



For relatively large (σ,θ), granularity is still present

Figure : $\sigma = 3.4$, $\theta = 6$



For relatively small (σ,θ), the LLN applies

Robustness: thinner Pareto tails

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- Thinner tail of firm sizes: $\frac{\theta}{\sigma-1} = 2.5$ (vs 0.92 in the baseline)
- Case 1: $\sigma = 7.5$, $\theta = 16.5$. Granularity is still present.

	log export / domestic sales					
	(1)	(2)	(3)	(4)	(5)	(6)
log Comp. Advantage	0.829**	0.861**	0.830**	0.851**	0.820**	0.884**
Dom. M.S. of 1st dom firm		10.423**				6.985**
Dom. M.S. of top 2-3 dom firm			15.421**			34.799**
log Ratio 1/ Median				0.812**		0.437***
Dom. M.S. of median firm					31.687**	-109.336**
log n domestic firm		0.089	0.127	-0.365**	-0.041	0.171**
R-squared	0.51	0.67	0.63	0.72	0.57	0.83

- Case 2: $\sigma = 3.4$, $\theta = 6$. No role played by granulariry here.

	log export / domestic sales					
	(1)	(2)	(3)	(4)	(5)	(6)
log Comp. Advantage	0.581**	0.571**	0.571**	0.569**	0.573**	0.567**
Dom. M.S. of 1st dom firm		2.297**				0.806
Dom. M.S. of top 2-3 dom firm			2.661**			4.243**
log Ratio 1/ Median				0.078**		0.026
Dom. M.S. of median firm					6.580**	-9.164
log n domestic firm		0.056**	0.068**	-0.008	0.042**	0.068**
R-squared	0.89	0.91	0.91	0.90	0.90	0.92