Betting on Exports: Trade and Endogenous Heterogeneity

Alessandra Bonfiglioli Rosario Crinò Gino Gancia

UPF/CEMFI/CREI and CEPR

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Motivation

- firm-level heterogeneity is crucial for studying
  - causes and consequences of trade
  - wage inequality
  - misallocations
  - aggregate productivity
- some well-know facts
  - firms are heterogeneous even in narrowly defined sectors
  - size distribution of all firms is highly skewed (Pareto with coefficient ~ 1)
  - wage size premium
  - exporters are more productive and pay higher wages
- yet, still limited understanding of the theoretical and empirical underpinnings of this heterogeneity

This Paper

- key questions
  - how does heterogeneity vary across sectors and time?
  - how does it vary with trade?
- existing answers
  - little empirical evidence on the determinants of firm heterogeneity
  - models focusing on entry/exit (Melitz) usually take the deep source of heterogeneity as given
  - models of firm growth often aimed at replicating a Pareto distribution with coefficient ~ 1
- our contributions
  1. document some new patterns in the data
  2. propose a model in which the extent of heterogeneity is endogenous
  3. explore new implications for wage dispersion in open economy

Preview of Main Results

- empirical patterns: standard deviation of log sales
  - varies greatly across US industries
  - has increased significantly over time (1997-2007)
  - covaries with average sales and export intensity
- a novel explanation
  - Melitz-type model in which firms, upon entry, choose to draw productivity from a menu of distributions with different variance
    - ★ trade-off: risky & large vs safe & small investment
- new effect of trade
  - by reallocating profits to the tail, trade induces firms to draw from riskier distribution
- extension: linking productivity to wages
  - trade amplifies wage dispersion by inducing more risk taking *ex-ante*

Globalization and Innovation Strategies: Examples

- Dell:
  - leader in "traditional" PCs, invests in R&D $\simeq$ 1% of revenue
  - revenue, 2005$\rightarrow$2013: \$49bn $\rightarrow$ \$57bn
- Apple:
  - *"Apple's strategy is really simple... We want to put an incredibly great computer in a book that you can carry around with you and learn how to use in 20 minutes ... and we want to do it with a radio link in it so... you're in communication with all of these larger databases and other computers."* Steve Jobs, 1983
  - risky (lots of failures), expensive (27 years to the iPad, R&D $\simeq$ 3-4% of revenue), high rewards:
    - ★ iPhone, 2007$\rightarrow$2015: 700mn units sold
    - ★ iPad, 2010$\rightarrow$2015: 250mn units sold
  - revenue, 2005$\rightarrow$2014: \$14bn $\rightarrow$ \$182bn
- our view: globalization made Apple's strategy so much more rewarding

Motivating Evidence: Data

- main measure of firm heterogeneity
  - standard deviation of the log of sales
- data: US Census of Manufacturing
  - $\sim$ 350 6-digit NAICS industries 1997-2002-2007
- data available for up to 19 sale-size bins only
  - we compute dispersion at the 6-digit level treating all firms in a bin as identical
    - ⋆ Helpman, Melitz & Yeaple (2004) show it is a good approximation
- industry-level covariates from various sources
  - US Census, NBER database, CPS...

Evidence: Descriptive Statistics

Dispersion of Sales - Descriptive Statistics

NAICS code	Industry Description	SD mean	SD min	SD max	SD % change	# establishments mean
327	Nonmetallic Mineral Product Manufacturing	1.931	0.989	3.556	0.163	728
322	Paper Manufacturing	1.943	0.964	2.269	0.334	252
332	Fabricated Metal Product Manufacturing	2.195	1.217	3.331	0.185	1387
313	Textile Mills	2.263	1.174	2.967	-0.054	258
315	Apparel Manufacturing	2.303	1.000	2.941	0.164	546
333	Machinery Manufacturing	2.318	0.483	3.212	0.043	498
326	Plastics and Rubber Products Manufacturing	2.385	1.359	3.077	0.204	1024
316	Leather and Allied Product Manufacturing	2.447	0.891	3.256	0.119	139
335	Electrical Equipment, Appliance, and Component Manufacturing	2.474	1.791	3.662	0.070	279
325	Chemical Manufacturing	2.529	0.915	4.015	0.044	394
331	Primary Metal Manufacturing	2.574	1.443	3.096	0.063	203
337	Furniture and Related Product Manufacturing	2.611	0.921	3.182	0.382	1753
312	Beverage and Tobacco Product Manufacturing	2.614	1.976	3.116	0.255	452
321	Wood Product Manufacturing	2.632	1.460	3.253	0.397	1187
339	Miscellaneous Manufacturing	2.724	0.947	3.670	0.332	1571
323	Printing and Related Support Activities	2.761	1.332	3.309	0.548	2773
334	Computer and Electronic Product Manufacturing	2.781	0.881	3.761	0.073	499
311	Food Manufacturing	2.805	1.181	4.567	0.280	549
314	Textile Product Mills	3.060	1.447	3.337	0.353	649
336	Transportation Equipment Manufacturing	3.225	1.723	4.221	0.040	404
324	Petroleum and Coal Products Manufacturing	4.311	0.750	4.477	1.256	482
	Total	2.826	0.483	4.567	0.285	720

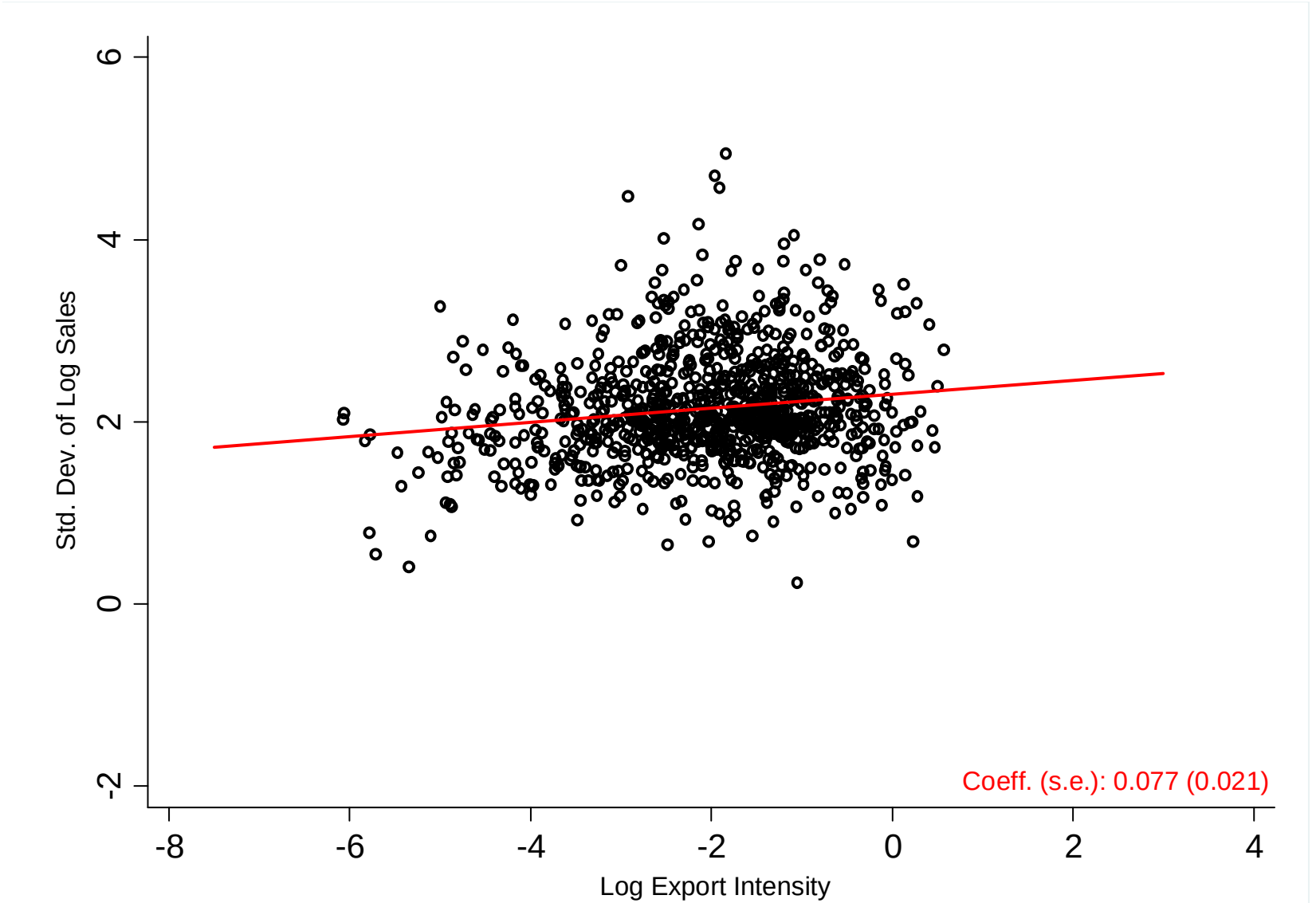
Note: SD is the standard deviation of the log sales. Percentage changes refer to the period between 1997 and 2007. Statistics are computed on data at 6-digit industry level. Source: US Census.

Evidence: Correlations

Dep. var.: Standard deviation of log establishment-level sales (unless otherwise indicated)

	OLS	OLS	OLS	OLS	OLS, Industry FE & First Differences				
	Baseline	GDP Growth	Industry FE	Industry FE & First Differences	Excl. Smallest Bins	Excl. Largest Bin	Dep.var.: S.D. log Labor Productivity	Import Penetration	Raw Bins
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Log export intensity	0.090***	0.087***	0.104**	0.189***	0.089*	0.163**	0.144***	0.187***	0.177***
	[0.019]	[0.019]	[0.053]	[0.069]	[0.048]	[0.079]	[0.037]	[0.069]	[0.067]
Log establishment-level sales	0.268***	0.283***	0.736***	0.507**	0.364**	0.104	0.265***	0.516**	0.524**
	[0.059]	[0.060]	[0.102]	[0.248]	[0.175]	[0.178]	[0.093]	[0.249]	[0.230]
Dummy differentiated industry	0.301***	0.302***							
	[0.063]	[0.064]							
Log number of establishments	0.110	0.127*	0.626***	0.959**	0.364	0.835**	0.765***	0.989**	0.817**
	[0.074]	[0.075]	[0.179]	[0.386]	[0.262]	[0.384]	[0.216]	[0.389]	[0.350]
Log employment	0.039	0.019	-0.387***	-0.304	-0.190	-0.098	-0.432***	-0.306	-0.313
	[0.072]	[0.074]	[0.112]	[0.328]	[0.227]	[0.280]	[0.141]	[0.330]	[0.314]
Log cap. intensity	0.023	-0.004	-0.178	0.105	-0.173	0.484**	0.129	0.087	0.102
	[0.119]	[0.119]	[0.222]	[0.194]	[0.140]	[0.208]	[0.170]	[0.193]	[0.172]
Log sk. intensity	-0.129**	-0.117**	0.398***	-0.140	-0.154	-0.079	0.021	-0.150	-0.055
	[0.058]	[0.058]	[0.117]	[0.194]	[0.129]	[0.190]	[0.083]	[0.196]	[0.180]
Log mat. intensity	-0.232	-0.266	-0.863**	0.283	-0.216	0.944**	0.193	0.228	0.127
	[0.192]	[0.194]	[0.361]	[0.420]	[0.281]	[0.423]	[0.256]	[0.420]	[0.387]
Log av. education	-0.028	-0.037	-1.050	-0.705	0.079	0.164	0.064	-0.723	-1.015
	[0.432]	[0.431]	[0.815]	[1.148]	[0.552]	[1.214]	[0.579]	[1.168]	[1.070]
S.D. log education	0.747*	0.735*	-0.405	-0.232	-0.140	-0.012	0.096	-0.244	-0.430
	[0.380]	[0.378]	[0.497]	[0.623]	[0.324]	[0.597]	[0.299]	[0.624]	[0.586]
GDP growth		2.381***	3.661***						
		[0.481]	[0.542]						
Log import penetration								0.025	
								[0.069]	
Obs.	928	928	928	695	685	668	689	692	695
R-squared	0.31	0.32	0.69	0.46	0.54	0.47	0.49	0.46	0.46

Globalization and Firm Heterogeneity



Identifying the Effect of Export Intensity

- two strategies:

1. **instrumental variables**: demand shocks in the destination markets for US exports
   - ⋆ **instrument**: exports from all non-US countries to the destination markets of US firms in each industry and year ($\sim$ Autor et al. 2013)
   - ⋆ isolates variation in export intensity due to foreign demand shocks (removes variation due to US industry-specific shocks)

2. **reduced form**: shocks to transportation costs
   - ⋆ **proxy**: average bulk weight (Kg/\$) of US shipments in each industry $\times$ log oil prices ($\sim$ Hummels et al. 2014)
   - ⋆ a reduction in oil prices leads to a larger fall in transportation costs for industries shipping heavier goods (diff-in-diff)

Evidence: IV and Diff-in-Diff

Dep. var.: Standard deviation of log establishment-level sales (unless otherwise indicated)

	Instrumental Variables					Difference-in-Difference				
	Baseline	GDP Growth	Industry FE	Industry FE & First Differences	Dep. var.: S.D. log Labor Productivity	Baseline	GDP Growth	Industry FE	Time FE	Dep. var.: S.D. log Labor Productivity
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Log export intensity	0.146***	0.145***	0.380**	0.741***	0.303***					
	[0.041]	[0.041]	[0.178]	[0.158]	[0.091]					
Bulk weight * Log oil price						-0.082***	-0.078***	-0.102**	-0.102**	-0.038**
						[0.028]	[0.028]	[0.043]	[0.043]	[0.016]
Log establishment-level sales	0.278***	0.292***	0.687***	0.810***	0.305***	0.231***	0.247***	0.688***	0.688***	0.085
	[0.059]	[0.060]	[0.106]	[0.231]	[0.100]	[0.066]	[0.068]	[0.145]	[0.145]	[0.078]
Bulk weight						0.115	0.101			
						[0.092]	[0.096]			
Log oil price						0.135***	0.128***	0.086		
						[0.036]	[0.036]	[0.059]		
Dummy differentiated industry	0.275***	0.276***				0.231***	0.235***			
	[0.066]	[0.066]				[0.080]	[0.080]			
Log number of establishments	0.134*	0.149**	0.578***	1.154***	0.757***	0.043	0.064	0.813***	0.813***	0.276**
	[0.073]	[0.074]	[0.185]	[0.419]	[0.231]	[0.079]	[0.082]	[0.214]	[0.214]	[0.130]
Log employment	0.031	0.012	-0.200	-0.527*	-0.436***	0.081	0.058	-0.425***	-0.425***	-0.146
	[0.072]	[0.073]	[0.159]	[0.317]	[0.148]	[0.083]	[0.086]	[0.162]	[0.162]	[0.104]
Log cap. intensity	0.045	0.020	-0.083	0.060	0.113	-0.016	-0.044	-0.299	-0.299	0.008
	[0.119]	[0.120]	[0.230]	[0.219]	[0.166]	[0.138]	[0.139]	[0.211]	[0.211]	[0.168]
Log sk. intensity	-0.154**	-0.143**	0.338***	0.030	0.034	-0.106	-0.098	0.356**	0.356**	0.089
	[0.061]	[0.061]	[0.128]	[0.200]	[0.087]	[0.065]	[0.065]	[0.139]	[0.139]	[0.098]
Log mat. intensity	-0.252	-0.283	-0.810**	-0.196	0.100	-0.191	-0.224	-0.898**	-0.898**	-0.189
	[0.190]	[0.192]	[0.353]	[0.461]	[0.263]	[0.209]	[0.212]	[0.367]	[0.367]	[0.319]
Log av. education	-0.301	-0.313	-1.323	-0.732	0.156	0.118	0.095	-1.968*	-1.968*	-0.228
	[0.452]	[0.450]	[0.848]	[1.219]	[0.589]	[0.456]	[0.455]	[1.013]	[1.013]	[0.704]
S.D. log education	0.622	0.607	-0.427	-0.204	0.149	0.667	0.633	-1.243**	-1.243**	-0.117
	[0.391]	[0.388]	[0.505]	[0.668]	[0.309]	[0.408]	[0.407]	[0.583]	[0.583]	[0.380]
GDP growth		2.210***	2.832***				1.862***	3.311***		
		[0.501]	[0.681]				[0.546]	[0.590]		
Obs.	916	916	910	664	654	738	738	738	738	733
Kleibergen-Paap F-Stat	30.8	30.8	66.3	73.9	85.9					
R-squared	-	-	-	-	-	0.32	0.33	0.66	0.66	0.48

What Can Explain These Patterns?

- rise in dispersion
  - granularity? *but results not driven by the number of firms or large firms*
  - misallocation? *but results not driven by the number of firms or small firms*
- trade and dispersion
  - reverse causality? *IV and diff-in-diff suggest against*
  - selection? *if anything, should lower dispersion (especially among small firms)*
  - reallocation towards large firms? *effect also holds for small firms & for labor productivity*
- hints towards our model
  - dispersion increased in all parts of the distribution
  - di Giovanni & Levchenko (2009): sectors more open to trade are more volatile $\longrightarrow$ riskier?

Related Literature

- innovation and firm heterogeneity
  - Acemoglu & Cao (2015), Poschke (2014), Jones & Kim (2014), Luttmer (2010), Geerolf (2014)
    - ⋆ *little attention on innovation risk (Gabler & Poschke, 2013)*
- trade with heterogeneous firms
  - entry/exit and reallocations: Melitz (2003), Melitz & Redding (2014)
  - endogenous productivity: Bernard, Redding & Schott (2011), Bustos (2011), Atkeson & Burstein (2010), Kugler & Verhoogen (2012), Dhingra (2013)
    - ⋆ *main focus on first moments (Mayer, Melitz & Ottaviano, 2015)*
- trade and wages with heterogeneous firms
  - competitive labor markets: Yeaple (2005), Monte (2011), Sampson (2014), Atkeson & Burstein (2010), Burstein & Vogel (2012)
  - labor market frictions: Helpman, Itskhoki & Redding (2010), Amiti & Davis (2012), Davis & Harrigan (2011) Egger & Kreickemeier (2009)
    - ⋆ *we propose a new channel linking trade to wage dispersion*

The Model Setup

- static, multi-sector version of Melitz (2003)
  - as in Redding & Melitz (2014)
- usual assumptions:
  - one factor, L
  - monopolistic competition
  - fixed cost of production (and of export)
  - fixed entry cost $\longrightarrow$ productivity drawn from a Pareto distribution
- new assumption:
  - at entry stage, firms can choose between Pareto distributions with different variance
    - ★ we characterize the endogenous choice of entry risk
- autarky equilibrium first, then trade with a symmetric country

Preferences

- unit mass of households with size L and utility:

$$U = q_0 + \sum_{i=1}^{I} \frac{\alpha_i X_i^{\zeta_i}}{\zeta_i}, \quad \zeta_i \in (0,1) \quad \alpha_i > 0$$

  - $q_0 > 0$, homogenous numeraire good
  - X_i = CES composite of differentiated varieties produced in industry i

$$X_i = \left[\int_{\omega \in \Omega_i} x_i(\omega)^{\frac{\sigma_i - 1}{\sigma_i}} \, d\omega \right]^{\frac{\sigma_i}{\sigma_i - 1}}, \quad \sigma_i > 1$$

- demand:

$$x_i(\omega) = X_i \left[\frac{P_i}{p_i(\omega)} \right]^{\sigma_i}$$

  - P_i = price index of X_i, $p_i(\omega)$ = price $x_i(\omega)$

- focus on a single industry, remove index i from now

Problem of the Firm: Production and Profit

- consider a firm with productivity φ
  - marginal cost: $1/\varphi$ units of labor (wage w)
  - fixed cost: f
- from profit maximization
  - markup pricing
$$p(\varphi) = \frac{\sigma}{\sigma - 1}\frac{w}{\varphi}$$
  - profit
$$\pi(\varphi) = A\varphi^{\sigma-1} - f$$
    - ⋆ where $A = \left(\frac{\sigma w}{\sigma-1}\right)^{1-\sigma}\frac{XP^{\sigma}}{\sigma}$
  - exit if $\varphi < \varphi^* = (f/A)^{1/(\sigma-1)}$
- least productive firms exit, more productive firms make higher profit

Problem of the Firm: Entry Stage

- firms can draw productivity from a family of Pareto distributions

$$G(\varphi) = 1 - (\varphi_{\min}/\varphi)^{1/v}, \quad v \in [\underline{v}, \bar{v}]$$

  - distributions differ in v = st.dev. of $\ln \varphi$
    - ★ v also affects the mean

$$\mathbb{E}[\varphi] = \varphi_{\min}(1-v)^{-1}$$

      $\rightarrow$ high risk $\rightarrow$ high average returns (not needed, but reasonable)

- expected profits *ex-ante*:

$$\mathbb{E}[\pi] = \int_{\varphi^*}^{\infty} \left(A\varphi^{\sigma-1} - f\right) \mathrm{d}G(\varphi) = \frac{f\varsigma}{1/v - \varsigma} \left(\frac{\varphi_{\min}}{\varphi^*}\right)^{1/v}$$

  - $\varsigma \equiv \sigma - 1$, assume $\bar{v} < 1/\varsigma$

Choice of Entry Risk: Trade-Off

- return to risk:
  - $\mathbb{E}[\pi]$ increasing in v

$$\frac{\partial \ln \mathbb{E}[\pi]}{\partial \ln v} = \frac{1}{1-v\varsigma} + \ln\left(\frac{\varphi^*}{\varphi_{\min}}\right)^{1/v} > 0$$

  1. direct effect: high $v \rightarrow$ high average productivity (not needed)
  2. cutoff effect: high $v \rightarrow$ higher $\Pr(\varphi > \varphi^*)$
  3. Hartman-Abel effect: profit function is convex in φ when $\varsigma > 1$ $(\sigma > 2)$

- cost of risk:
  - assume entry cost, $\lambda F(v)$, is an increasing and convex function of v

$$F'(v) > 0 \quad \text{and} \quad F''(v) > \partial^2 \mathbb{E}[\pi] / \partial v^2$$

- v chosen to solve: $\max_{v \in [\underline{v}, \bar{v}]} \{\mathbb{E}[\pi] - \lambda F(v)\}$

Equilibrium Choice of Entry Risk

- first-order condition: $\frac{\partial \mathbb{E}[\pi]}{\partial v} = \lambda F'(v)$
  - imposing free entry

$$\mathbb{E}[\pi] = \lambda F(v) \quad \rightarrow \quad \left(\frac{\varphi^*}{\varphi_{\min}}\right)^{1/v} = \frac{f}{\lambda F(v)} \frac{\varsigma}{1/v - \varsigma}$$

  - equilibrium v is pin down by

$$\ln\left[\frac{f}{\lambda F(v)} \frac{\varsigma}{1/v - \varsigma}\right] + \frac{1}{1 - v\varsigma} = \frac{vF'(v)}{F(v)}$$

- comparative statics
  - $\frac{dv}{d\varsigma} > 0 \rightarrow \uparrow \varsigma$ makes the profit function more convex
  - $\frac{dv}{df} > 0 \rightarrow \uparrow f$ raises the exit cutoff $\rightarrow$ shifts expected profits to the tail
  - $\frac{dv}{d\lambda} < 0 \rightarrow \downarrow \lambda$ raises the exit cutoff $\rightarrow$ shifts expected profits to the tail

Equilibrium Dispersion Across Industries

- equilibrium productivity, φ, and revenue, r, are Pareto
  - $\ln \varphi$ and $\ln r$ are exponential:

$$Var\left[\ln \varphi\right] = v^2 \quad \text{and} \quad Var\left[\ln r\right] = \left(v\varsigma\right)^2$$

- dispersion of productivity and revenue higher in industries with
  - high elasticity of substitution
  - high fixed cost
  - low entry cost λ

- consistent with the data
  - product differentiation, growth
  - positive correlation between dispersion and $\mathbb{E}\left[r\right] = \frac{\sigma f}{1-v\varsigma}$

Adding Trade

- export to a symmetric country
  - fixed cost f_x, iceberg variable cost $\tau > 1$
  - profit from exporting

$$\pi_x(\varphi) = A(\varphi/\tau)^{\sigma-1} - f_x > 0 \quad \text{if} \quad \varphi > \varphi_x^* = \tau(f_x/A)^{1/\varsigma}$$

- *ex-ante* expected profits
  - domestic and export markets

$$\mathbb{E}[\pi] = \frac{\varsigma}{1/v - \varsigma}\left[f\left(\frac{\varphi_{\min}}{\varphi^*}\right)^{1/v} + f_x\left(\frac{\varphi_{\min}}{\varphi_x^*}\right)^{1/v}\right]$$

  - return to risk

$$\frac{\partial \ln \mathbb{E}[\pi]}{\partial \ln v} = \frac{1}{1 - v\varsigma} + \ln\left(\frac{\varphi^*}{\varphi_{\min}}\right)^{1/v} + \frac{\ln(\varphi_x^*/\varphi^*)^{1/v}}{(\varphi_x^*/\varphi^*)^{1/v} f/f_x + 1}$$

    - ★ two cutoff effects: domestic and export

Export Opportunities, Risk and Dispersion

- how do trade affect the return to risk?
  - "export opportunities" $\rho \equiv \varphi^* / \varphi_x^* = (f / f_x)^{1/\varsigma} / \tau$
  - impose free entry

$$\mathbb{E}[\pi] = \lambda F(v) \quad \rightarrow \quad \left(\frac{\varphi^*}{\varphi_{\min}} \right)^{1/v} = \frac{\varsigma}{1/v - \varsigma} \frac{f + f_x \rho}{\lambda F(v)}$$

  - ρ raises the return to risk:

$$\frac{\partial^2 \ln \mathbb{E}[\pi]}{\partial \ln v \partial \rho} = \frac{f / f_x}{\rho^{1+1/v}} \frac{\ln \rho^{-1/v}}{v \left(\rho^{-1/v} f / f_x + 1 \right)^2} > 0$$

  - why? trade reallocates profits to the right tail of the distribution
    - ★ extra prize of exporting $\rightarrow$ more risk taking
- implications:
  - trade raises equilibrium dispersion, $\frac{dv}{d\rho} > 0$, and expected productivity

From Productivity to Wage Inequality

- productivity dispersion can map into wage inequality
  - more productive firms pay higher average wages
    - ★ e.g., Oi & Idson (1999), Troske (1999), Dunne et al. (2004)
- extend our model following Helpman, Itskhoki & Redding (HIR, 2010)
  - Melitz (2003) + labor market frictions
    - ★ random search and matching
    - ★ unobservable worker ability heterogeneity
    - ★ costly screening by firms
  - main predictions: wages proportional to productivity + exporter premium
- new result:
  - by making firms more unequal, trade raises wage dispersion for all firms

Technology

- output of firm with φ productivity, h employees of average ability $\bar{a}$:

$$y = \varphi h^{\gamma} \bar{a}$$

  - $\gamma \in (0,1) \rightarrow$ DRS (e.g., span of control model)
  - ability a unobservable and Pareto: $G_a(a) = 1 - (1/a)^k$
- firm pays bn to match randomly with $n \geq h$ workers
- firm pays $\frac{ca_c^{\delta}}{\delta}$ to screen out workers with $a < a_c$

$$\bar{a} = \frac{k}{k-1} a_c \quad \text{and} \quad h = n \left(\frac{1}{a_c} \right)^k$$

  - assume $k < 1/\gamma$ (screening profitable)
- wage bargaining (Stole & Zwiebel, 1996):
  - firm's share of revenues $= 1/(1+\beta\gamma)$, with $\beta \equiv 1 - 1/\sigma$

Firm's Problem

- firm solves

$$\pi(\varphi) = \max_{n, a_c, \mathbb{I}} \left\{ \frac{r(\varphi)}{1+\beta\gamma} - bn - \frac{c a_c^{\delta}}{\delta} - f - \mathbb{I} f_x \right\}$$

  - where $\mathbb{I}$ =1 iff the firm exports
  - $r(\varphi) = (1 + \mathbb{I}\tau^{1-\sigma})^{1-\beta} P X^{1-\beta} (\varphi \bar{a})^{\beta} h^{\beta\gamma}$

$$\text{FOC for } n \quad : \quad \frac{\beta\gamma}{1+\beta\gamma} r(\varphi) = bn(\varphi)$$

$$\text{FOC for } a_c \quad : \quad \frac{\beta(1-\gamma k)}{1+\beta\gamma} r(\varphi) = b a_c(\varphi)^{\delta}$$

  - more productive firms:
    - ★ sample more workers and screen more (higher n and a_c)
- selection
  - $\varphi < \varphi^*$ exit and $\varphi > \varphi_x^*$ export

Entry and Industry Equilibrium

- entry stage
  - *ex-ante* expected profits

$$\mathbb{E}[\pi] = \frac{\varsigma}{1/v - \varsigma}\left[f\left(\frac{\varphi_{\min}}{\varphi^*}\right)^{1/v} + f_x\left(\frac{\varphi_{\min}}{\varphi_x^*}\right)^{1/v}\right]$$

    where $\varsigma \equiv \beta/\Gamma$ with $\Gamma \equiv 1 - \beta\gamma - (1-\gamma k)\beta/\delta$

- industry equilibrium
  - free entry

$$\left(\frac{\varphi^*}{\varphi_{\min}}\right)^{1/v} = \frac{\varsigma}{1/v - \varsigma}\frac{f + f_x\rho}{\lambda F(v)}$$

  - same formulas in ς and $\rho = \varphi^*/\varphi_x^*$ $\rightarrow$ isomorphic choice of v
    - ★ but now ς (convexity of profits) depends on more parameters

$$\frac{dv}{d\gamma} > 0, \quad \frac{dv}{d\delta} < 0, \quad \frac{dv}{dk} < 0$$

Trade and Wage Dispersion

- wage paid by firms with productivity φ:

$$w(\varphi) = \left(1 + \mathbb{I}\tau^{1-\sigma}\right)^{\frac{k(1-\beta)}{\delta\Gamma}} \varphi^{\frac{\beta k}{\delta\Gamma}} w(\varphi^*)$$

  - increases in productivity
  - exporter premium ($\mathbb{I}$ =1 if $\varphi > \varphi_x^*$, else 0)

- effect of trade, ρ, on wage inequality:
  - as in HIR, exporter premium $\longrightarrow$ inverted-U effect
  - moreover, ρ makes the distribution of φ more unequal

- new result:
  - trade raises wage dispersion among workers in domestic firms and among workers in exporting firms

Conclusions

- firm heterogeneity (st.dev. sales)
  - has increased over time
  - varies positively with export intensity
- one possible explanation
  - firm can choose the risk of their initial productivity draw
- main result
  - export opportunities amplify heterogeneity (in productivity and wages) by inducing more risk taking
- future work
  - more evidence to establish causality, evidence on risk taking
  - evidence on wage dispersion
  - normative implications $\longrightarrow$ excessive risk taking?
  - add innovation by incumbents