An Anatomy of International Trade: Evidence from French Firms

(preliminary work in progress)

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(joint with Jonathan Eaton and Francis Kramarz)

The Project

- Long-term project: a better model for quantitative international trade.
- EKK (2004): new regularities about firms' export penetration, exploits unique French data.
- This talk: very simple model captures these regularities, reveals underlying connections between them, and suggests others.
- Future potential payoff: (i) refine model of trade, (ii) quantify cost of entry, (iii) quantify gains from variety, (iv) simulate gains from market integration.

The Data

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- Data on nearly all French firms.
- Merged with Customs declarations on firm exports.
- Exports by firm for each foreign market (focus on 113 countries, including France itself).
- So far, 1986 cross-section in manufacturing (over 200,000 firms).
- Aggregating firm data by market, lines up well with aggregate figures on French exports by market. But, 20% undercounting.

Dissection I: Markets per Firm

- Typical French firm sells only in France: only 40,000 export.
- Typical exporter sells in only one or two foreign markets.
- Distinctive shape of markets-per-firm distribution (Figure 1).
- Firms penetrating more markets are much larger (Figure 2).

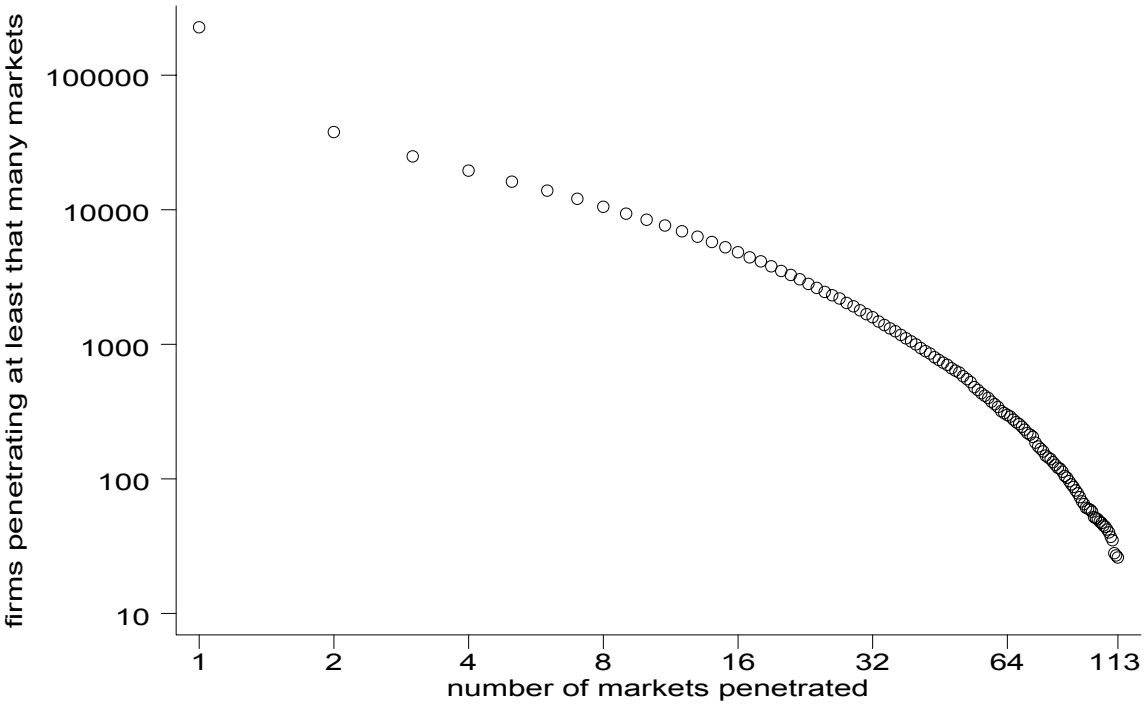

Figure 1: Frequency of Selling in Multiple Markets

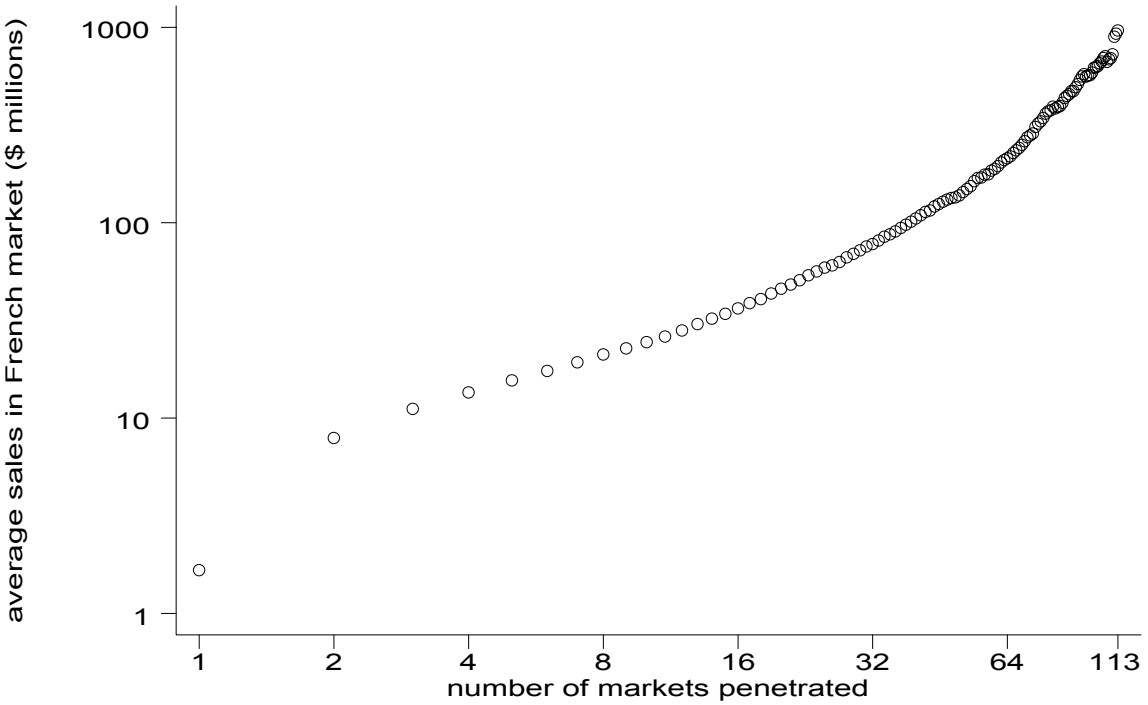

Figure 2: Firm Size and Market Penetration

Dissection II: Firms per Market

- Huge variation in French entry (exporters) J_{nF} across markets n (Figure 3).

- Variation in J_{nF} related to market size X_n, and French market share π_{nF}:

$$\ln J_{nF} = +\beta_S \ln \pi_{nF} + \beta_X \ln X_n$$

  with $\beta_S = .87$ and $\beta_X = .62$ ($R^2 = .90$). BEJK (2003) predicts $\beta_S = 1$, but wildly off predicting $\beta_X = 0$.

- Huge variation in sales among firms exporting to a particular market (Figure 4).

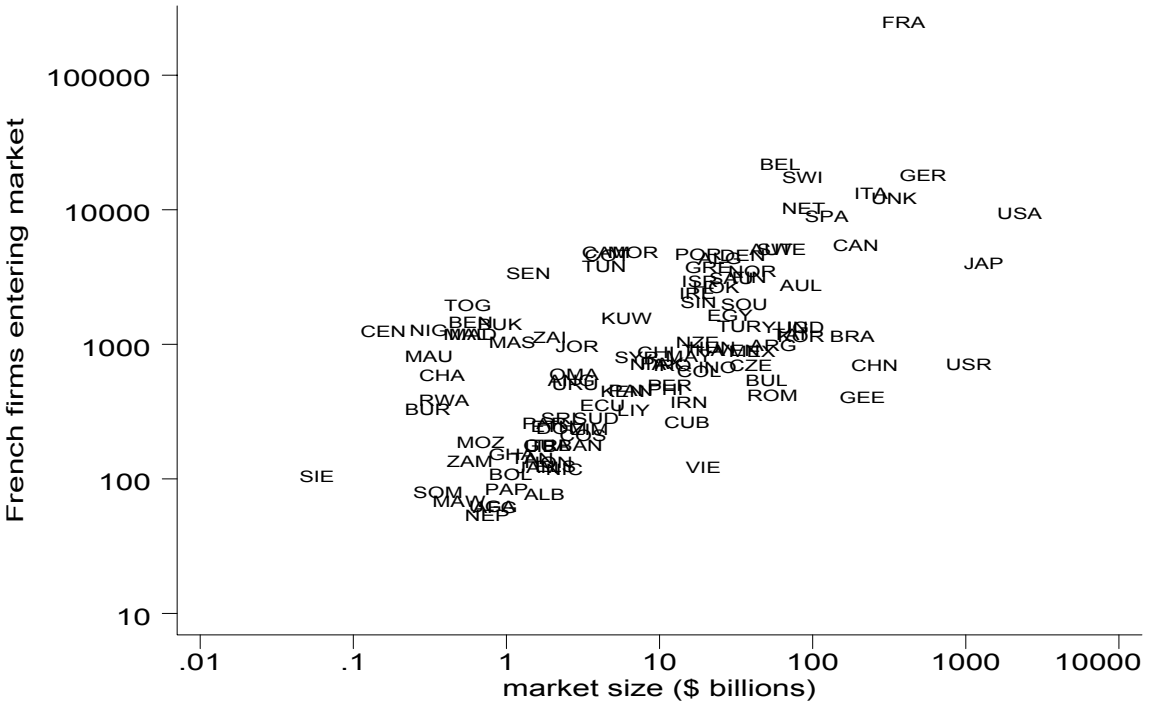

Figure 3: French Firm Entry and Market Size

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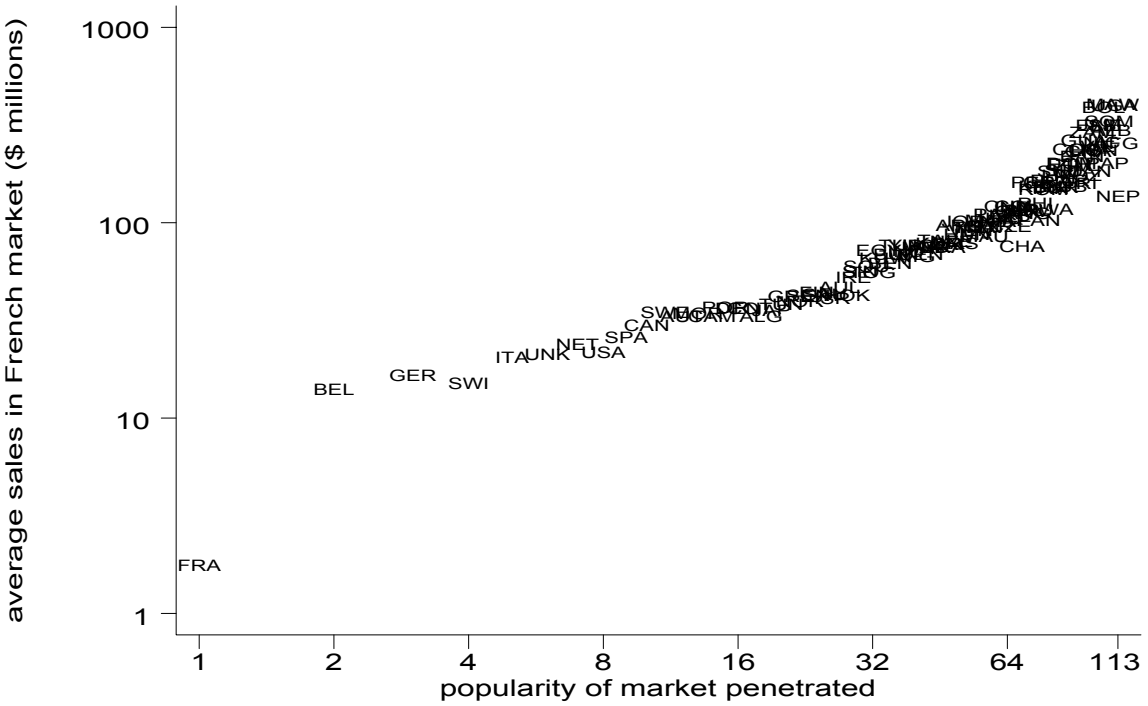

Figure 2b: Firm Size and Popularity of Market

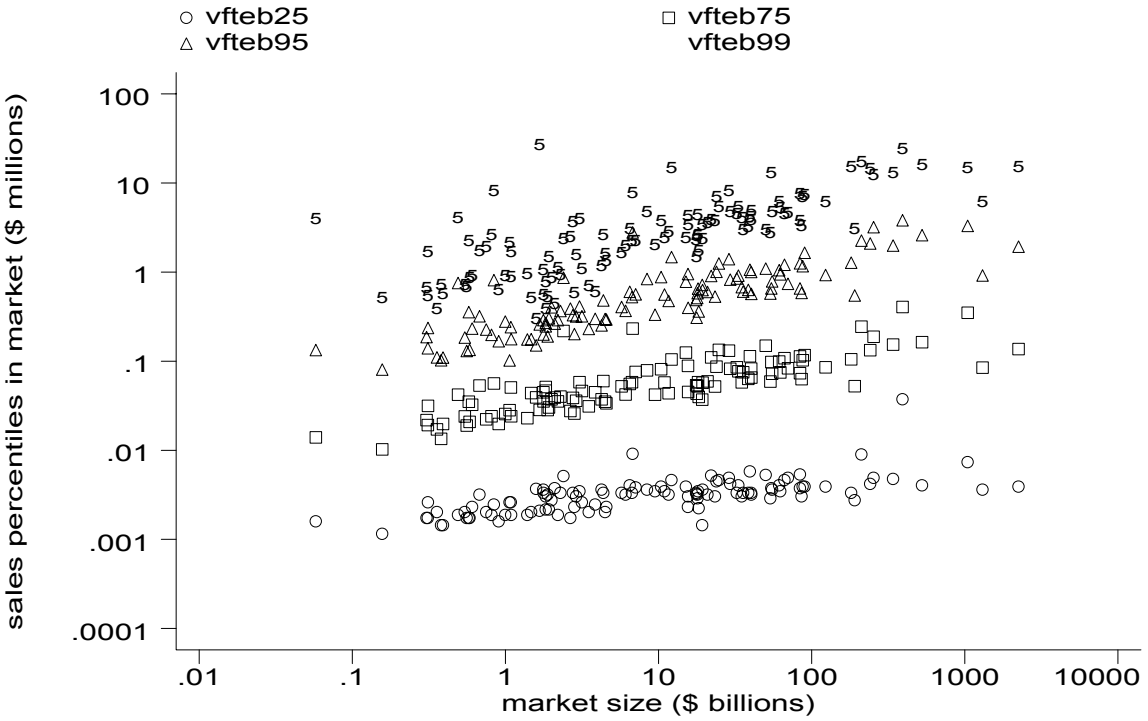

Figure 4: Distribution of Sales by Market

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Challenges, Opportunities, and Strategies

- Challenge of extreme heterogeneity and fragmented markets.
- Yet some striking regularities.
- In earlier unpublished work, we generalized BEJK (2003) to incorporate fixed entry costs.
- For key regularities, stripped down version of Melitz (2003) is not bad, as we discovered recently!
- Simpler model is a good baseline: crystal clear predictions, easy to diagnose failures.
- In progress: model to nest BEJK (2003) and Melitz (2003). May do better on geographic patterns.

Simplest Model

- Dixit-Stiglitz preferences and monopolistic competition as in Krugman (1981).
- Combined with heterogeneity in firm efficiencies as in Melitz (2003).
- Fixed cost of entry per market and Pareto distribution of efficiencies as in Helpman, Melitz, and Yeaple (2004) and Ruhl (2004).
- Strip out all dynamics and many results from EK (2002) and BEJK (2003) carry through.

I. Countries as Consumers

- Countries $n = 1, \ldots, N$.
- Continuum of goods in n, indexed $j \in [0, J_n]$.
- Market size X_n (aggregate expenditure).

- Expenditure on good j:

$$X_n(j) = X_n \left[\frac{p_n(j)}{P_n} \right]^{-(\sigma-1)}, \sigma > 1.$$

- If good not supplied to n, set $p_n(j) = \infty$.
- Price level:

$$P_n = \left[\int_0^{J_n} p_n(j)^{-(\sigma-1)} dj \right]^{-1/(\sigma-1)}.$$

II. Countries as Producers

- Firm in country i with efficiency z has unit cost w_i/z.
- Delivers to country n at cost $d_{ni}w_i/z$.
- Country i has $T_i z^{-\theta}$ firms with efficiency greater than z.

- Firms in i that can supply a good to n at cost less than c:

$$J_{ni}(c) = T_i(w_i d_{ni})^{-\theta} c^{\theta}$$

- Across all souces:

$$J_n(c) = \sum_{i=1}^{N} T_i(w_i d_{ni})^{-\theta} c^{\theta} = \Phi_n c^{\theta}$$

III. Market Structure and Entry

- A firm chooses to supply a unique good j.
- Decides which countries to sell in, paying entry cost E_n for each n it enters.
- If firm decides to enter country n, maximizes profit there by charging $p_n(j) = [\sigma/(\sigma-1)]c_n = \overline{m}c_n$.
- Enters market n iff it can supply at cost less than $\overline{c}_n$:

$$E_n = (X_n/\sigma)\left[\frac{\overline{m}\overline{c}_n}{P_n}\right]^{-(\sigma-1)}.$$

- Given $\overline{c}_n$, price level is

$$P_n = \left[\int_0^{\overline{c}_n}(\overline{m}c)^{-(\sigma-1)}dJ_n(c)\right]^{-1/(\sigma-1)}.$$

Familiar Results

- Fraction of $J_n = J_n(\overline{c}_n)$ that n imports from i (σ irrelevant):

$$\pi_{ni} = J_{ni}(\overline{c}_n)/J_n(\overline{c}_n) = T_i(w_i d_{ni})^{-\theta}/\Phi_n$$

- Fraction of firms entering n with cost below c (i is irrelevant): $J_{ni}(c)/J_{ni}(\overline{c}_n) = (c/\overline{c}_n)^{\theta}$
- Fraction of firms entering n selling less than x there:

$$F(x) = 1 - \left(\frac{x}{\sigma E_n}\right)^{-\theta/(\sigma-1)}.$$

- Sales in n independent of i means $X_{ni}/X_n = \pi_{ni}$.

Results on Firms per Market

- Number of firms from i entering n: $J_{ni} = \frac{X_{ni}}{X_n} J_n$.
- Mean sales of firms entering n: $\overline{x}_n = \frac{\sigma E_n}{1 - \frac{\sigma - 1}{\theta}}$.
- Since $X_n = \overline{x}_n J_n$:

$$J_{ni} = \frac{1 - \frac{\sigma - 1}{\theta}}{\sigma} \left(\frac{X_{ni}}{X_n} \right) \left(\frac{X_n}{E_n} \right) = \frac{1 - \frac{\sigma - 1}{\theta}}{\sigma E_n} X_{ni}.$$

- Let $x(p)_n$ be p'th sales percentile in n. Thus:

$$\ln \frac{x(p)_n}{\overline{x}_n} = \frac{-(\sigma - 1)}{\theta} \ln(1 - p) + \ln(1 - \frac{(\sigma - 1)}{\theta}).$$

Results on Markets per Firm

- Market hierarchy for firms from i: if enter market n then enter all n' for which $J_{n'i} \geq J_{ni}$.
- Let $J_i^{(1)} \geq J_i^{(2)} \geq \ldots \geq J_i^{(N)}$ be the ordered J_{ni}. Then $J_i^{(k)}$ is number of firms selling to at least k markets.
- A more efficient firm from i will sell to at least as many markets as a less efficient firm from there.
- Suppose $J_{n'i} = J_i^{(k)}$. For some market n more popular than n', let $\overline{x}_{ni}^{(k)}$ be mean sales in n of firms from i selling to at least k markets:

$$\overline{x}_{ni}^{(k)} = \frac{\sigma E_n}{1 - \frac{\sigma-1}{\theta}} \left(\frac{J_i^{(k)}}{J_{ni}} \right)^{-(\sigma-1)/\theta} .$$

- Examine by setting both i and n to be France.

Testing the Implications

- Entry and market size (Figure 5). Implies E_n increasing with elasticity of .36 in X_n. (Note French data point).
- Normalized sales (export) distributions (Figure 6). Implies $(\sigma - 1)/\theta = 1.78$ (inadmissable, but slope approaches -1 in the tail).
- Market hierarchies (Figure 7). Not bad, but obvious violations (nearly half of firms selling to only two markets do not sell to Belgium).
- Sales in France and export penetration (Figure 8). Wow! Implies $(\sigma - 1)/\theta = .65$ (In BEJK, $\sigma = 3.75, \theta = 3.60$ so $(\sigma - 1)/\theta = .76$).
- Implications of Figures 6 and 8 are at odds.

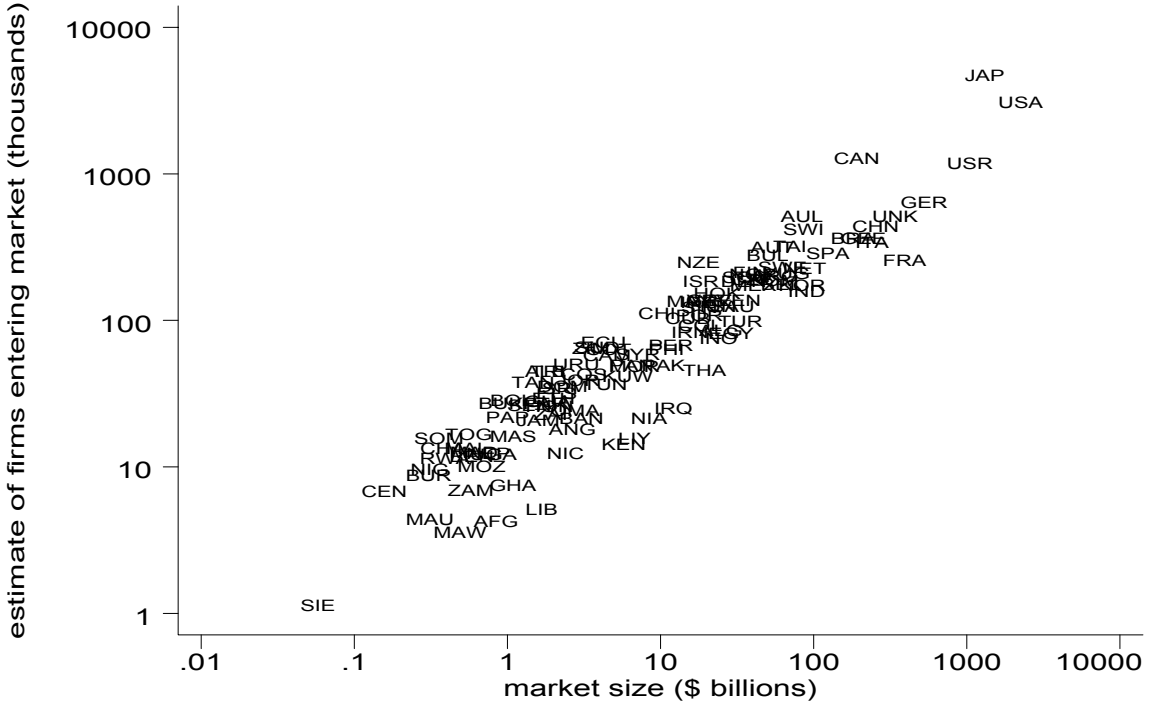

Figure 5: Entry and Market Size

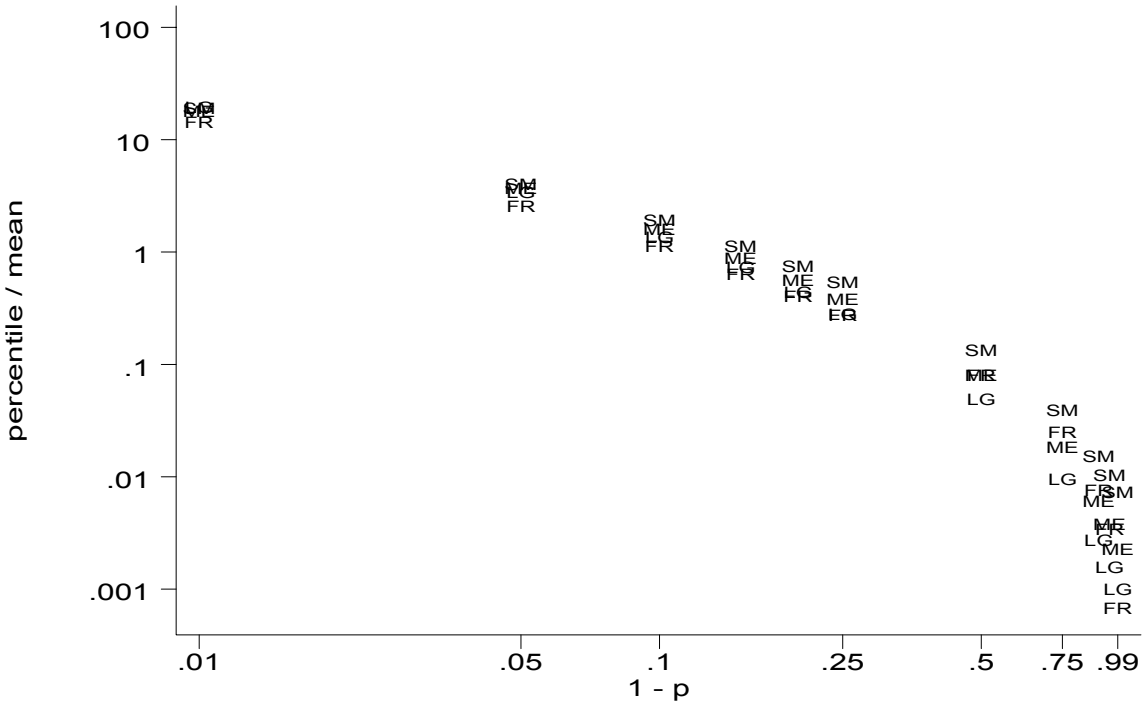

Figure 6: Distribution of Sales, by Market Size

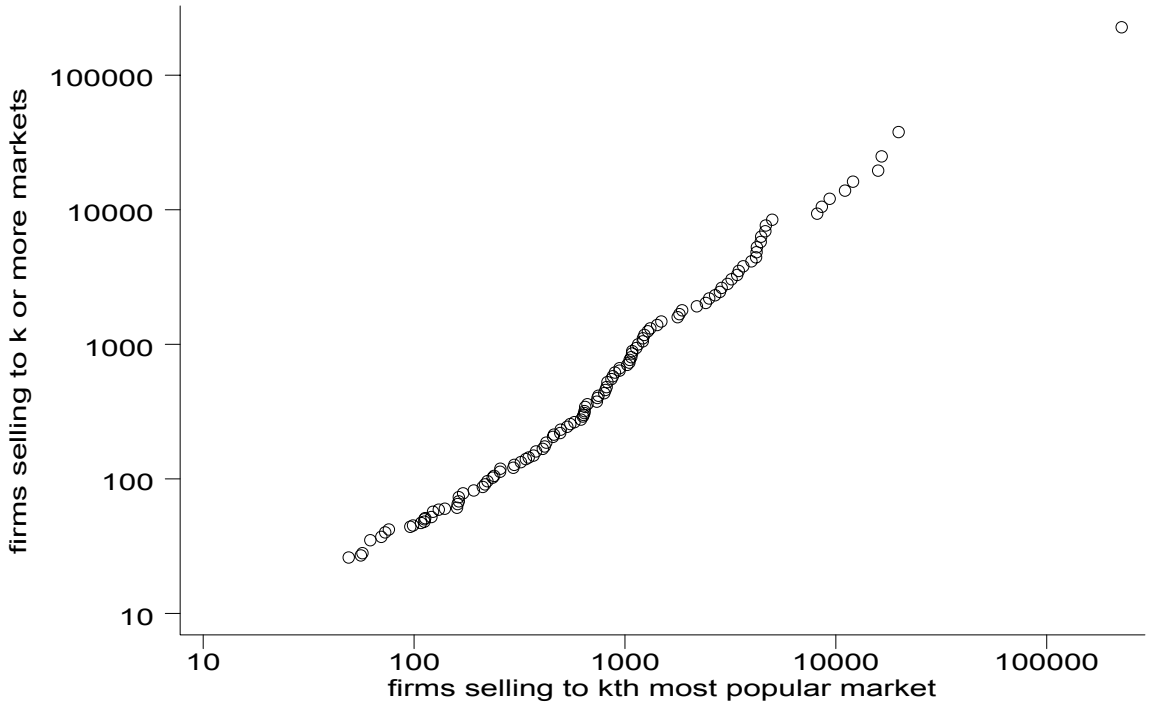

Figure 7: Market Hierarchy for French Firms

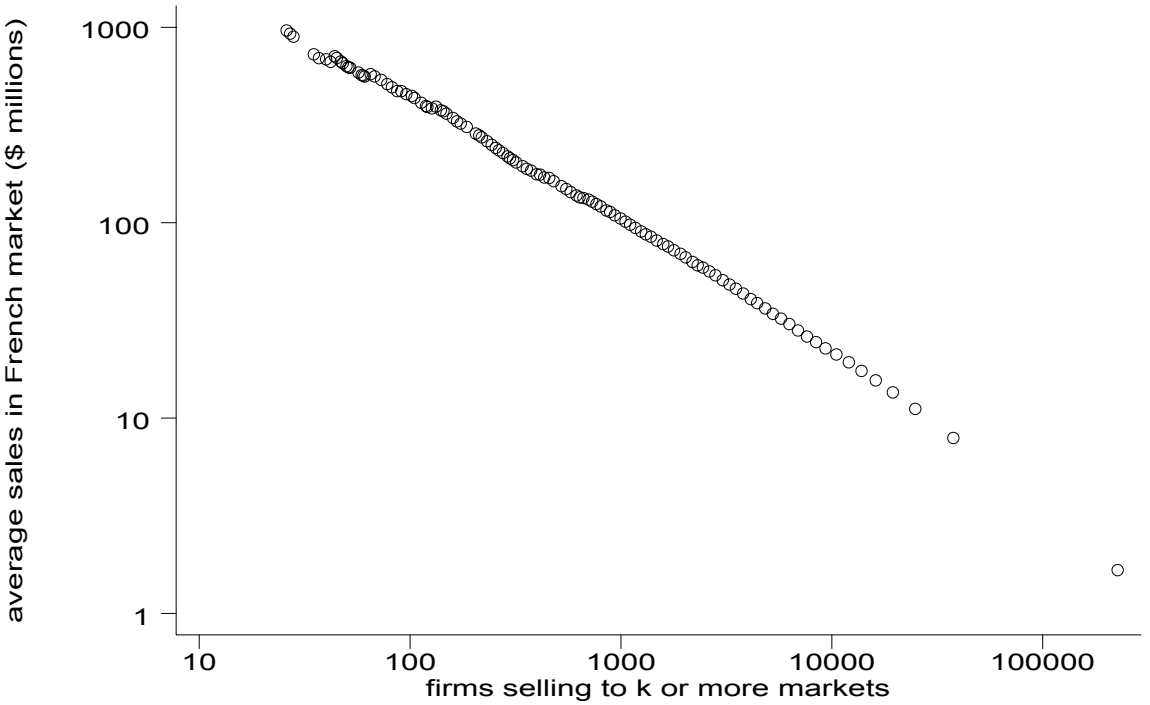

Figure 8: Firm Size and Frequency of Multiple Markets

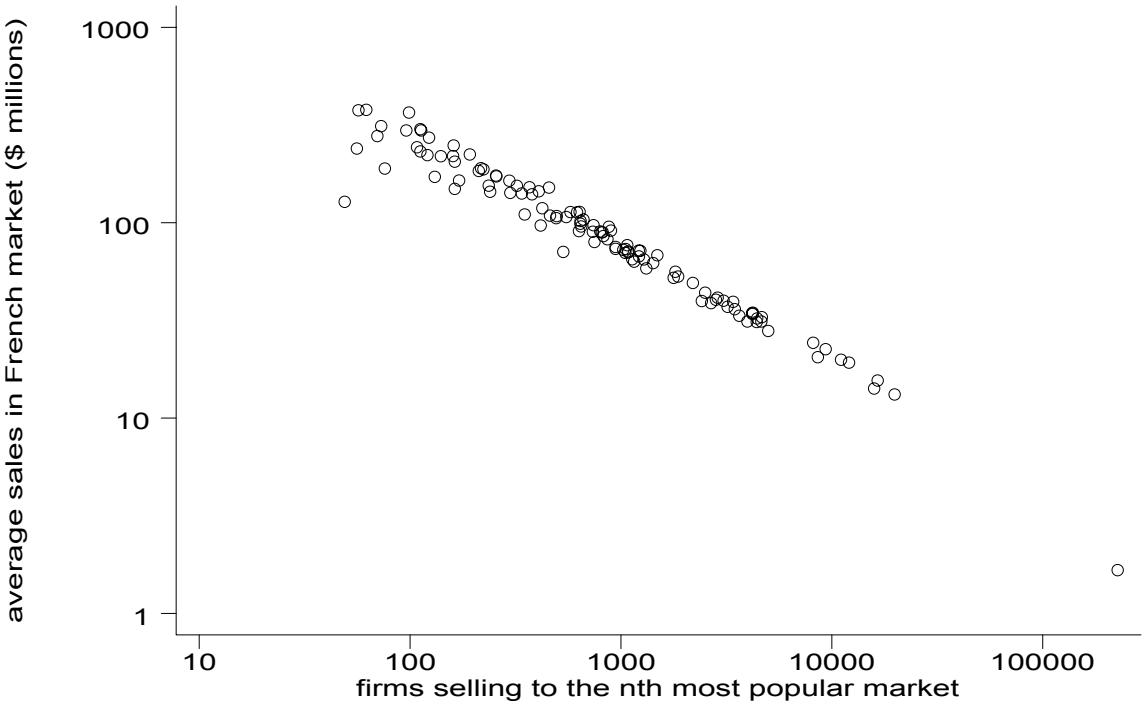

Figure 8b: Firm Size and Popularity of Market

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Generalizing the Model I

- Problem: concavity and thick tails apparent in Figure 6, normalized sales distributions.

- Potential solution I: introduce another reason, α, for firms to be big:

$$X_n(j) = \alpha(j) X_n \left[\frac{p_n(j)}{P_n} \right]^{-(\sigma-1)}, \sigma > 1.$$

- Turns out that α is irrelevant. Large α firms have lower cost threshold for entry. Resulting distribution of sales is unchanged.

Generalizing the Model II

- Potential solution II: introduce a reason, β, for firms to sell small amounts, $E_n(j) = \beta(j)E_n$.
- Variation in β alters sales distribution, leaving other implications in tact.

- Fraction of firms in n selling more than x:

$$\left[\int_0^{x/\sigma E_n} (x/\sigma E_n)^{-\theta/(\sigma-1)} dG(\beta) + \int_{x/\sigma E_n}^{\infty} \beta^{-\theta/(\sigma-1)} dG(\beta)\right] / \Gamma,$$

$$\Gamma = \int_0^{\infty} \beta^{-\theta/(\sigma-1)} dG(\beta).$$

- Choose $G(\beta)$ to fit normalized sales distributions (Figures 6a-6c).
- Also helps explain tiny lower support of distributions.

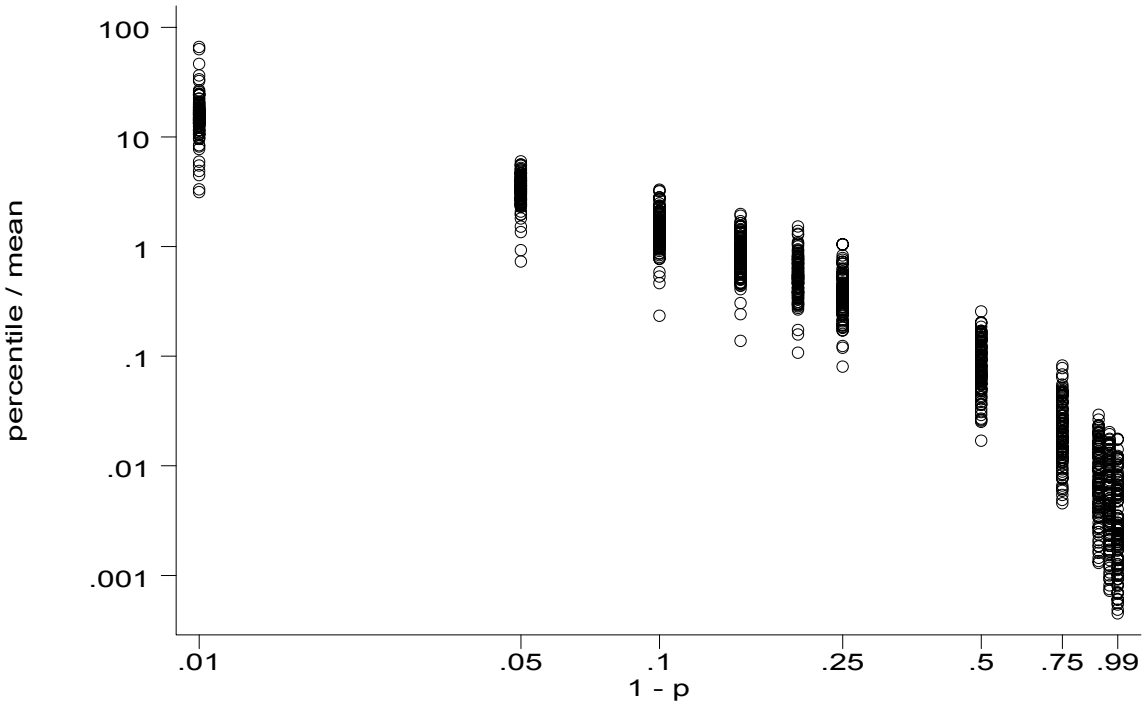

Figure 6a: Distribution of Sales (all markets)

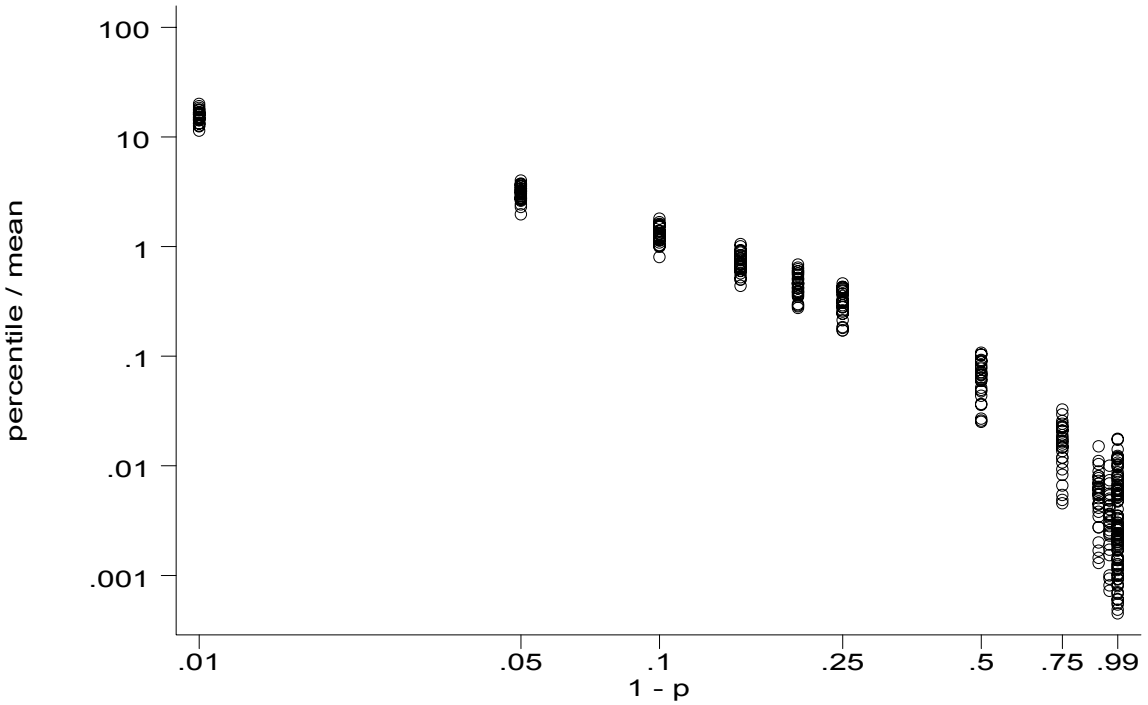

Figure 6b: Distribution of Sales (top 25% mkts.)

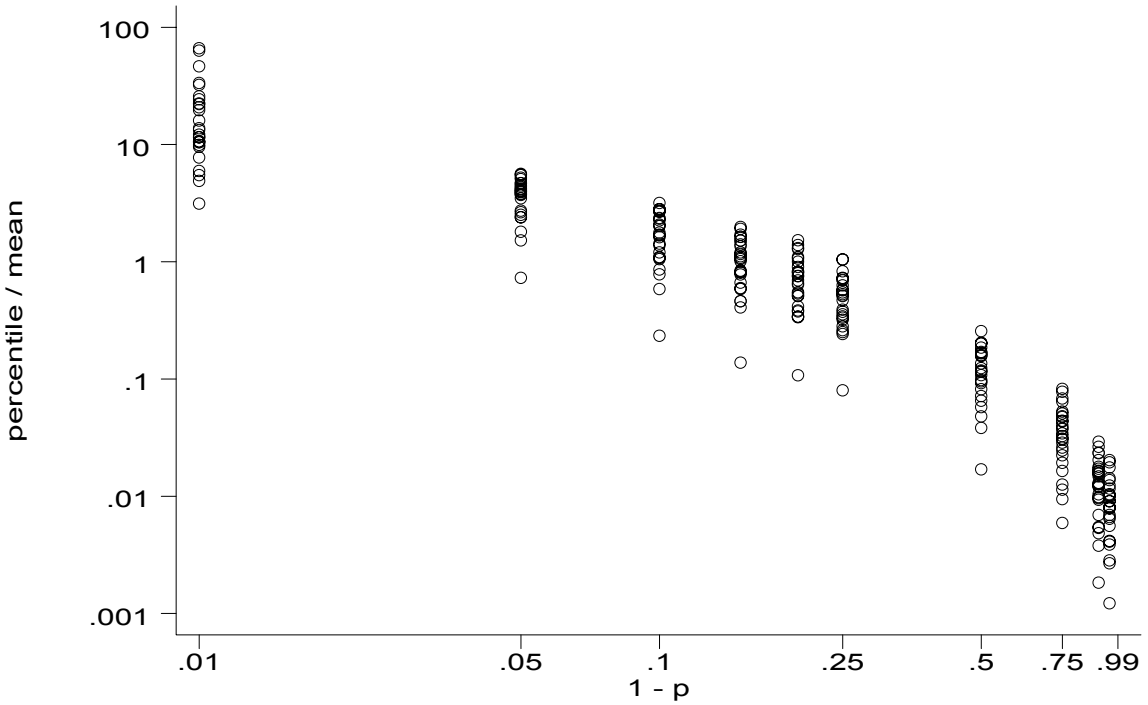

Figure 6b: Distribution of Sales (lowest 25%)

Accomplished So Far

- Simple model does well making sense of the most basic facts from EKK (2004).
- Reduces facts about French exporters per market to a simple entry-market size relationship.
- Reduces facts about variation in firm-level export volumes to a common shaped size distribution as it appears in different markets.
- Connects facts about the popularity of markets and facts about markets per firm, via market hierarchy.
- Connects facts about the frequency of penetrating multiple export markets to facts about sales in France as they vary with export penetration.
- More implications that we have not yet tabulated.

Room for Improvement

- Obvious problems:
  - strong hierarchy prediction is violated
  - can't capture geographic patterns in export destinations.
  - bad model of firm variation in output per worker.
- EK (2002) and BEJK (2003) with entry costs as in EKK (2004a) may help along each of these dimensions, but is less transparent. Potentially more parsimonious explanation of Figure 5.
- Fundamental distinction: can firms differentiate their product, or do they face competitors for their own product line? Does more entry lead to more competition?

What Next?

- Estimate parameters of the simple model with heterogeneous entry costs: $(\sigma - 1)/\theta$, $G(\beta), \sigma E_n$, $E_n = \eta(X_n)^\gamma$ given data on X_n and X_{nF}.
- Use estimates to assess gains from variety, and potential gains from market integration.
- Document geographic patterns at firm level. Is there a compelling argument for a richer model.
- If yes, build model that nests Melitz and BEJK, estimate it, and assess gains from variety and market integration.
- ...Dynamics of market entry, foreign direct investment .