Fourth Summer School in Trade, Industrialisation, and Development 2005

Gargnano, Italy

Trade, Innovation, and Technology Diffusion: Implications for Developing Countries

Lecture 4: Producer Level Analysis of Export Behavior

September 2005

The Data

- Tax data on nearly all French firms, indicating employment, domestic sales, etc.

- Merged with Customs declarations on firm exports and imports.

- Exports by firm for each foreign market (200+ destinations reduced to 113 countries).

- So far, 1986 cross-section in manufacturing (230,000 + firms).

- Firm export data line up well with aggregate data, with about 20% missing quite uniformly

Cutting the Data

- Dissection I: Overall firm export participation (as in previous work).
- Dissection II: Markets per firm (new).
- Dissection III: Firms per market (new).
- Dissection IV: Country and Firm Effects in Sales (new)

Dissection I

- Typical French manufacturer exports nothing (about 40,000 report exporting).
- Typical exporter sells less than 10 % abroad.
- Size and productivity advantage of exporters.
- Strikingly similar for U.S. plants (Bernard and Jensen).

Dissection II

- Typical French exporter sells in only one foreign market.
- Distinctive shape of markets-per-firm distribution (Figure 1)
- Firms selling to more markets are much larger and more productive (Figure 2)

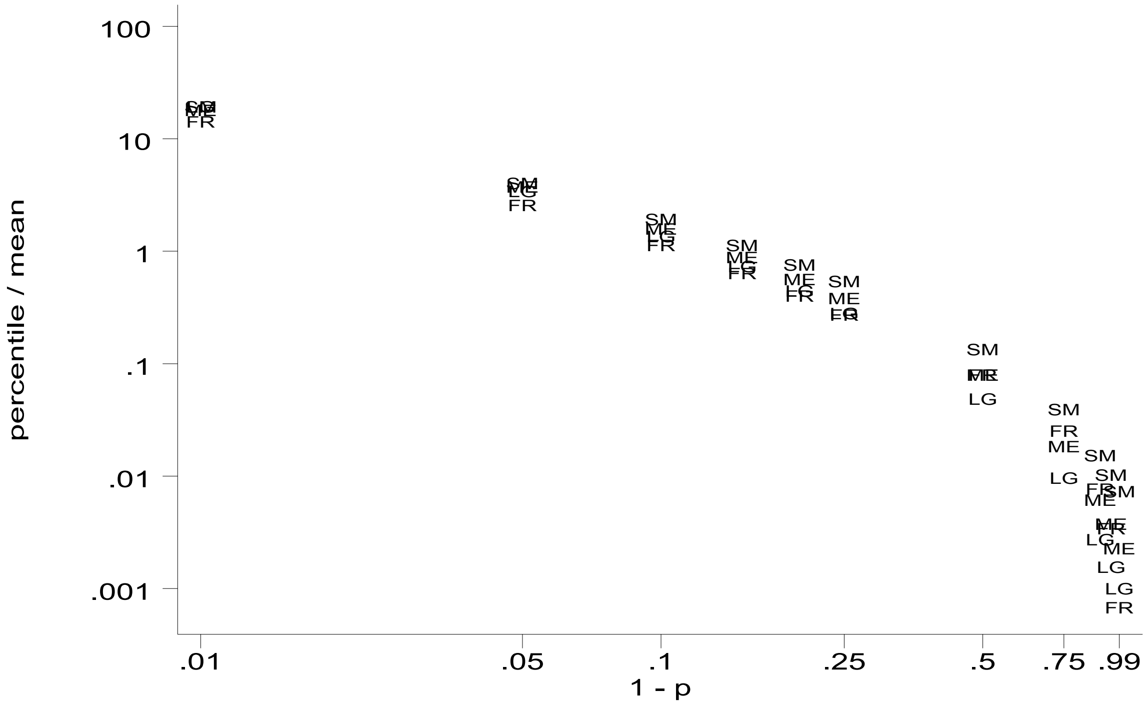


Figure 6: Distribution of Sales, by Market Size

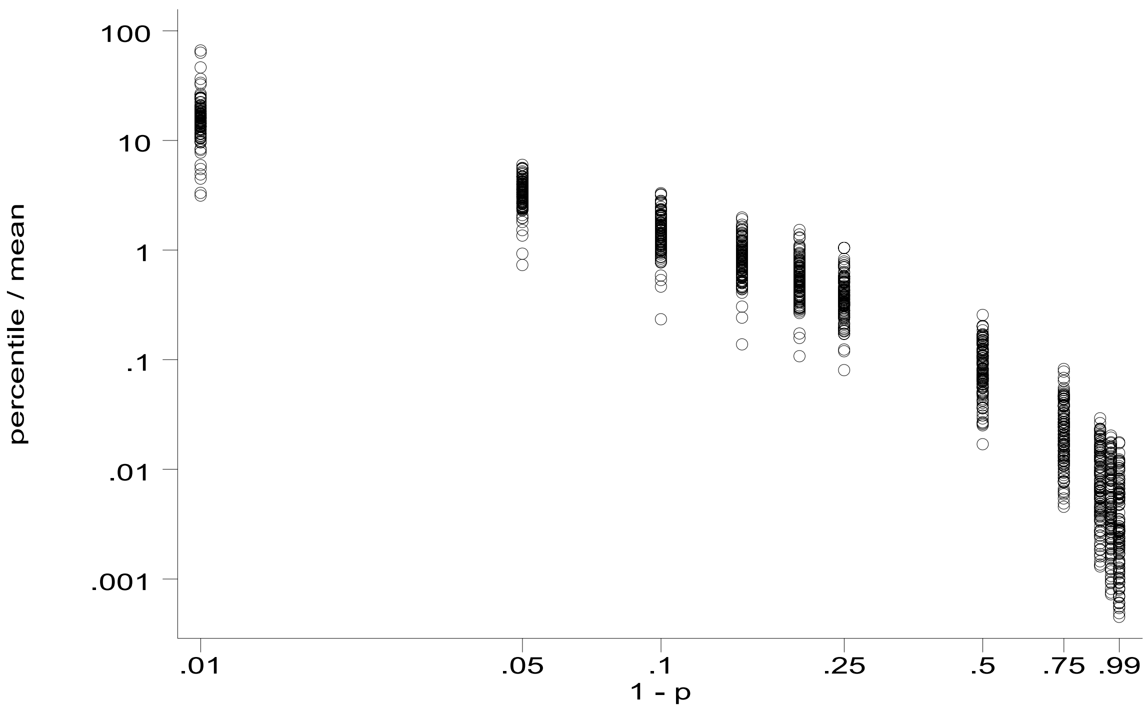


Figure 6a: Distribution of Sales (all markets)

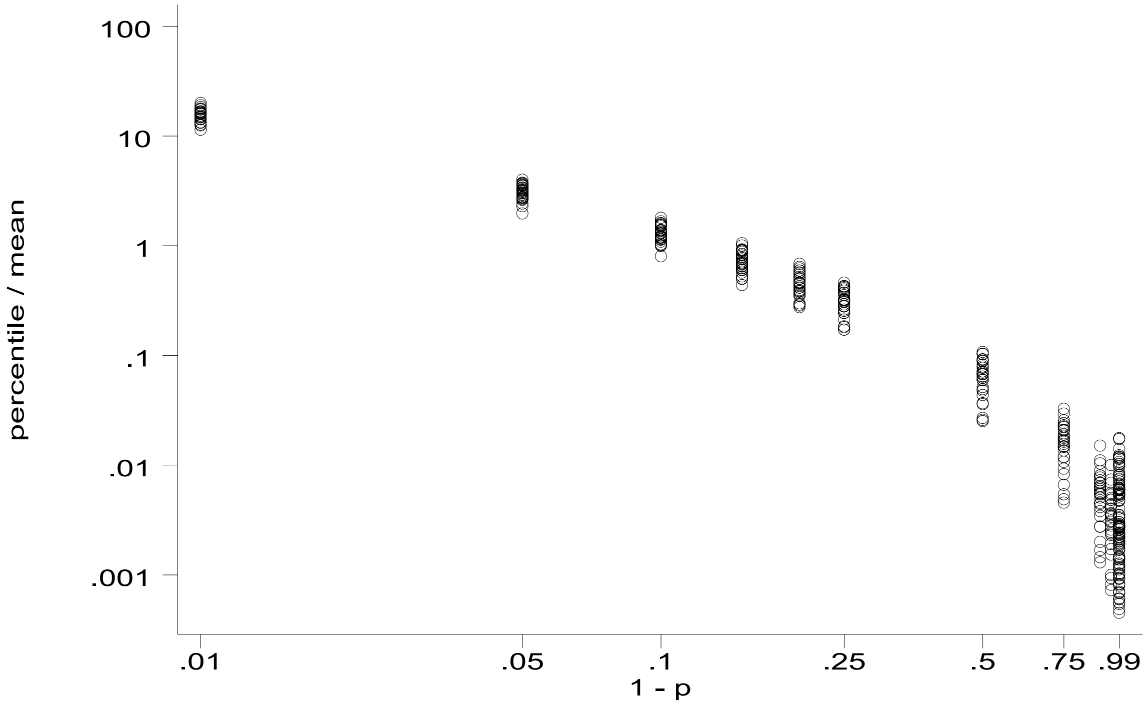


Figure 6b: Distribution of Sales (top 25% mkts.)

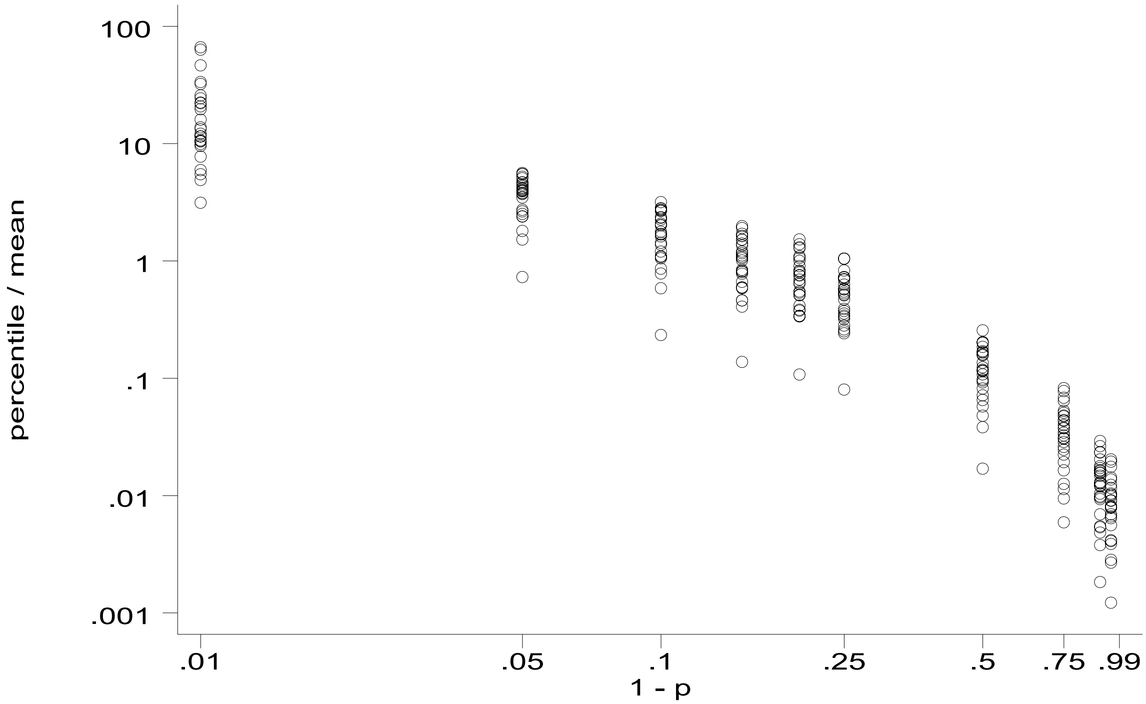


Figure 6b: Distribution of Sales (lowest 25%)

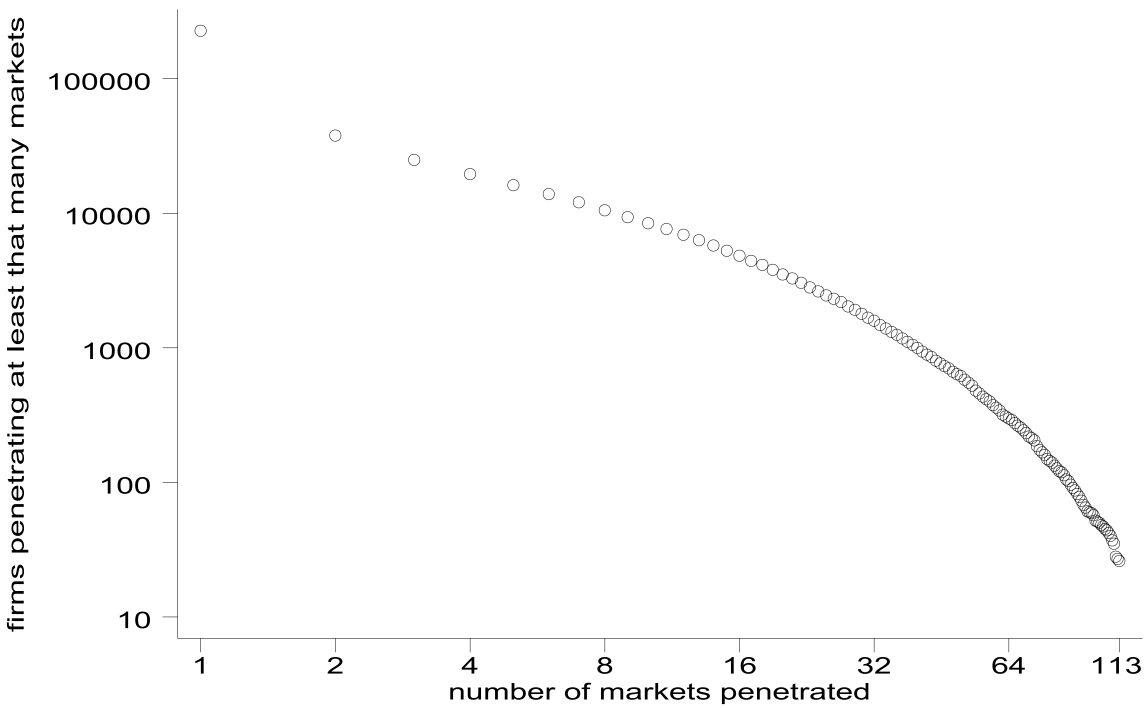


Figure 1: Frequency of Selling in Multiple Markets

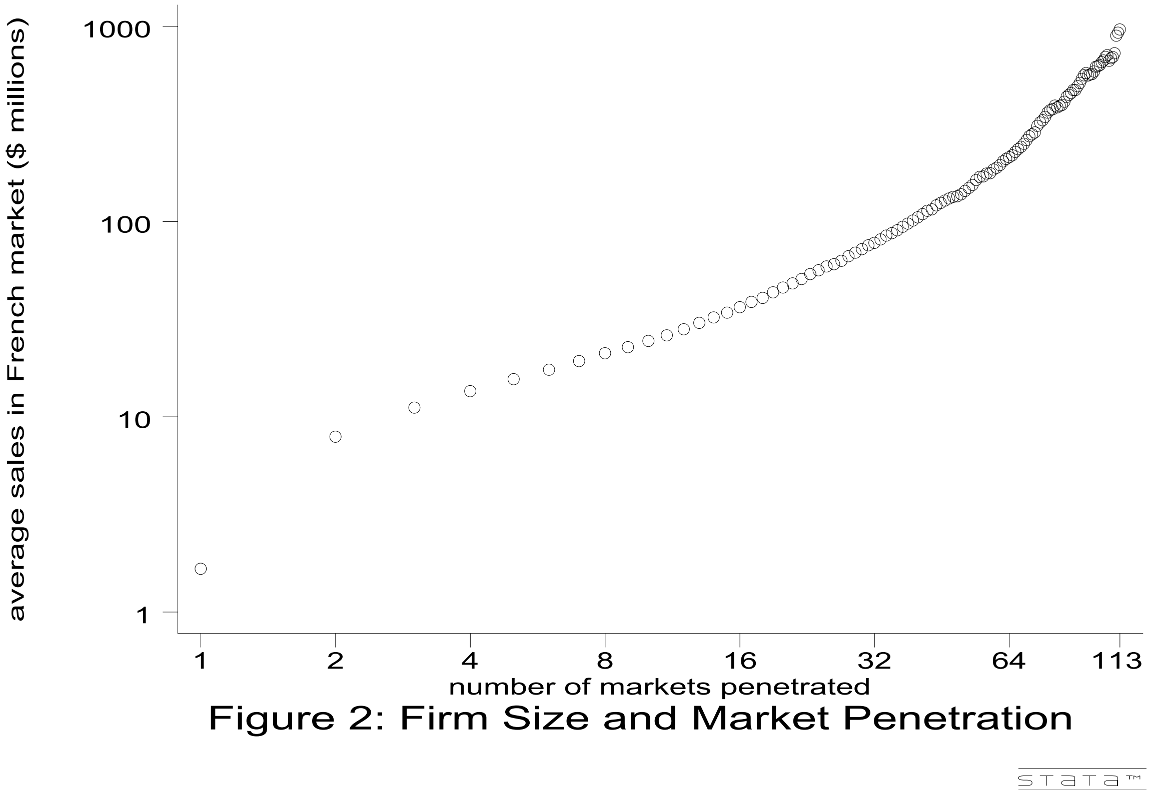


Figure 2: Firm Size and Market Penetration

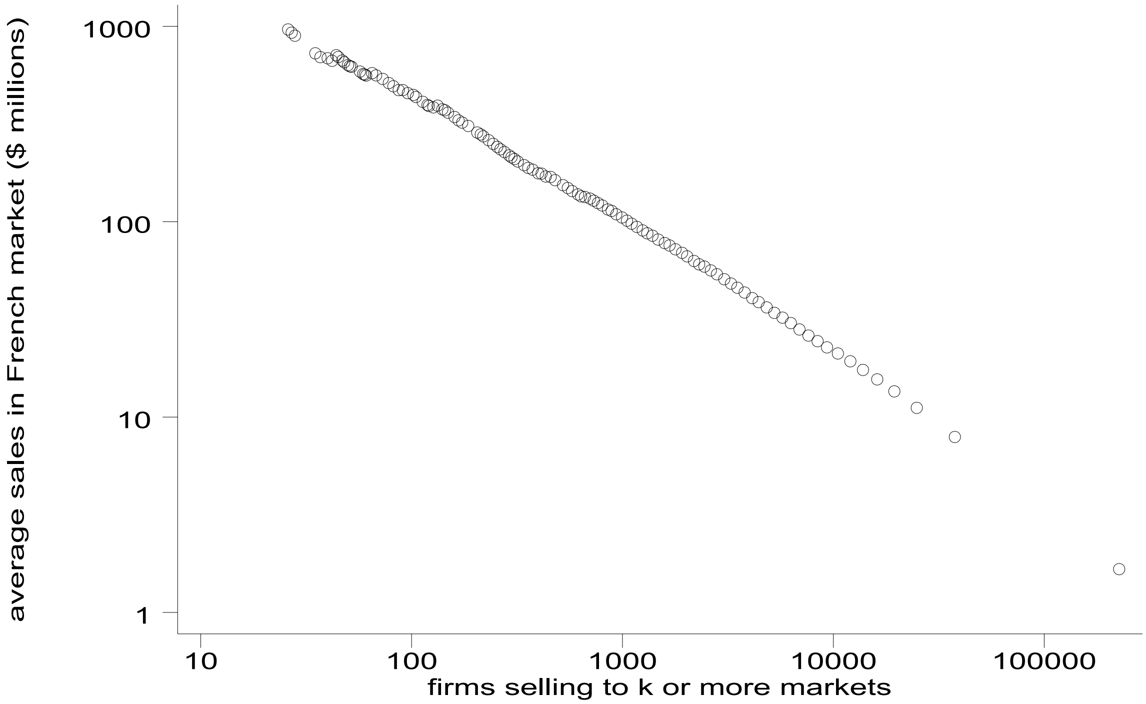


Figure 8: Firm Size and Frequency of Multiple Markets

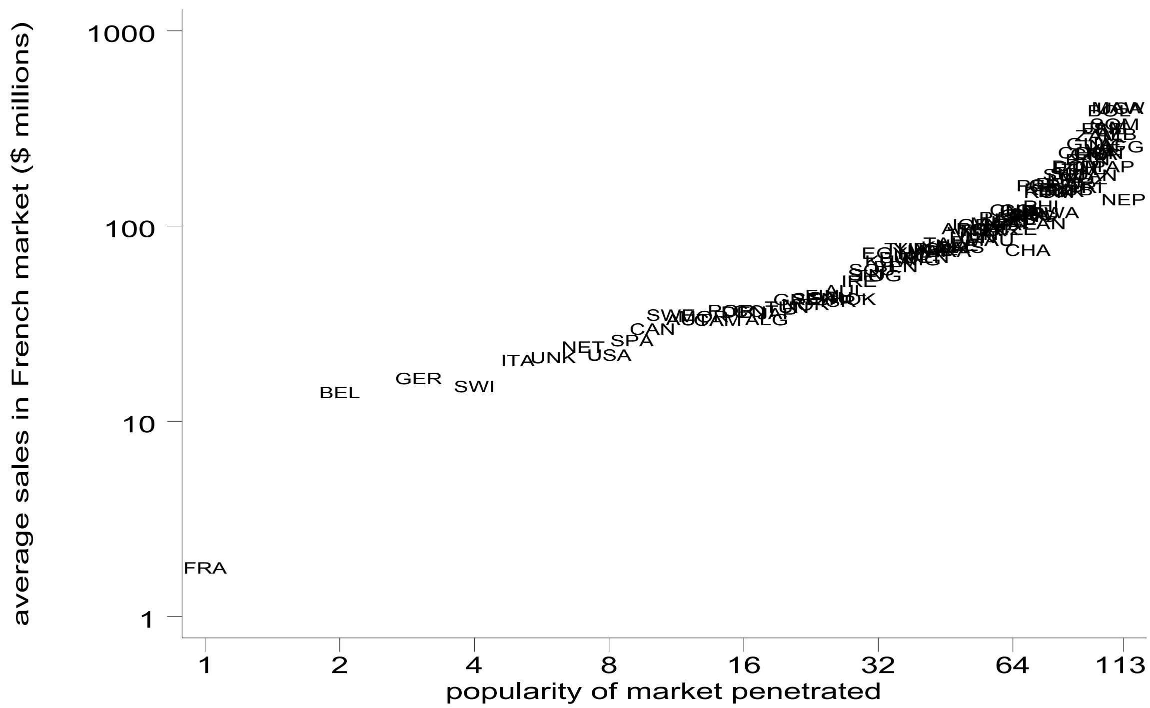


Figure 2b: Firm Size and Popularity of Market

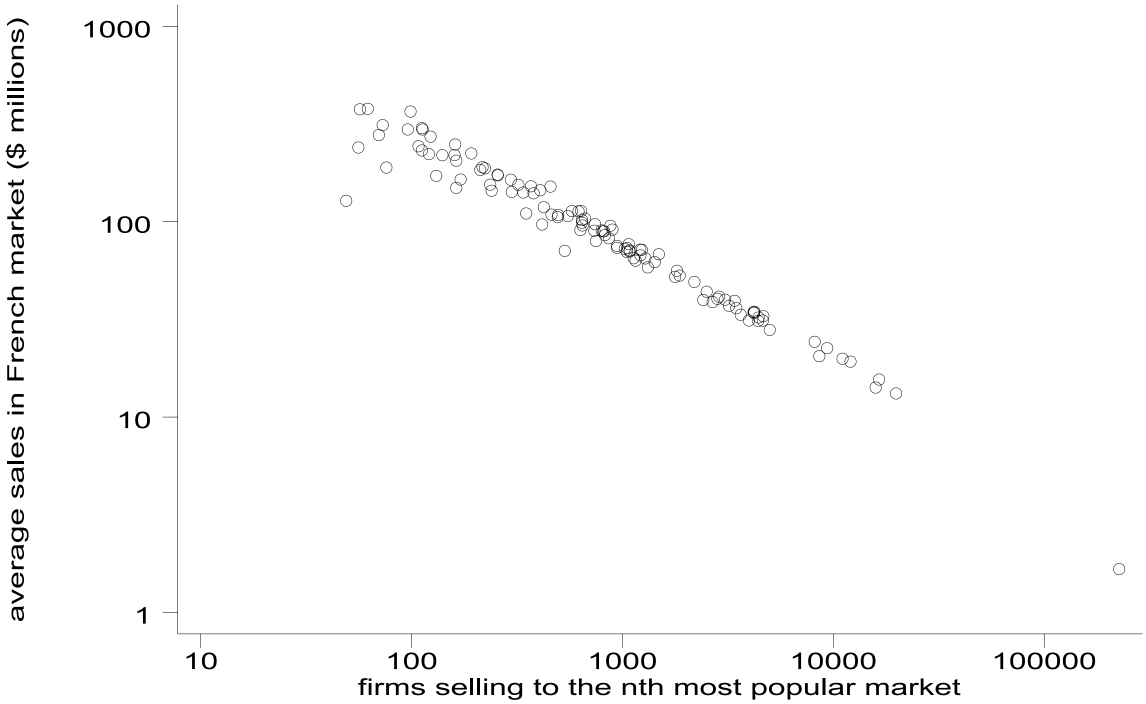


Figure 8b: Firm Size and Popularity of Market

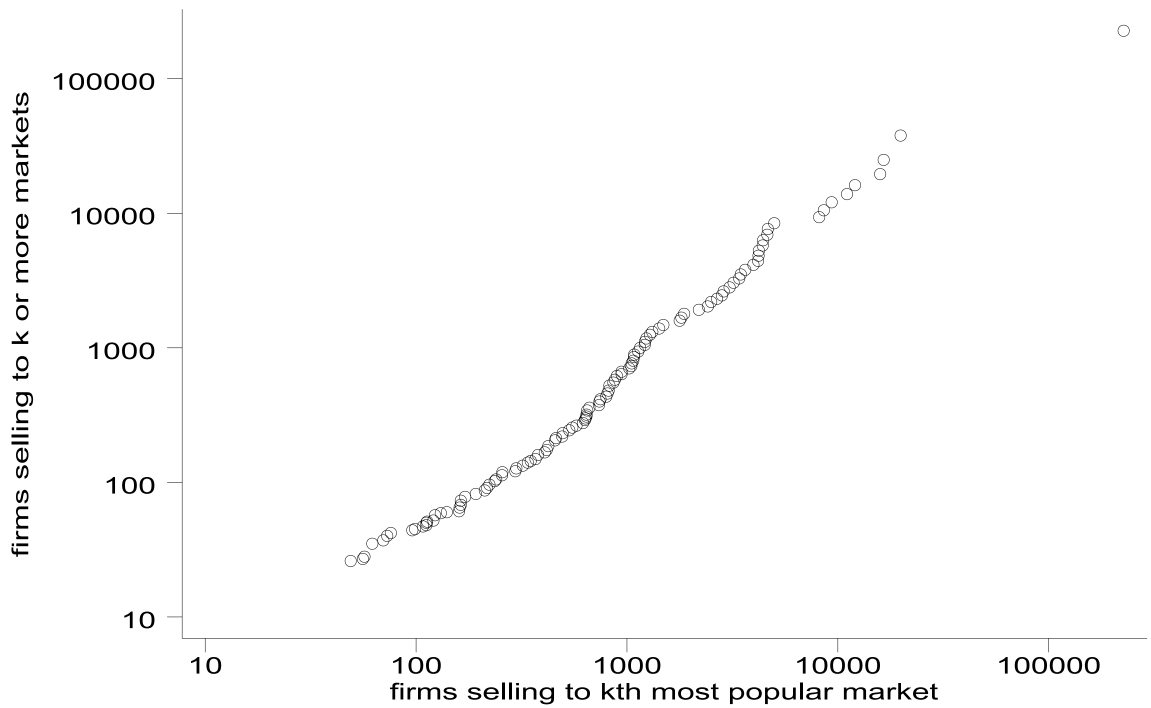


Figure 7: Market Hierarchy for French Firms

Dissection III

- Firm (micro) data line up by market with UN (macro) data (20% under-counting).

- Huge variation in number of French exporters N_n across markets n.

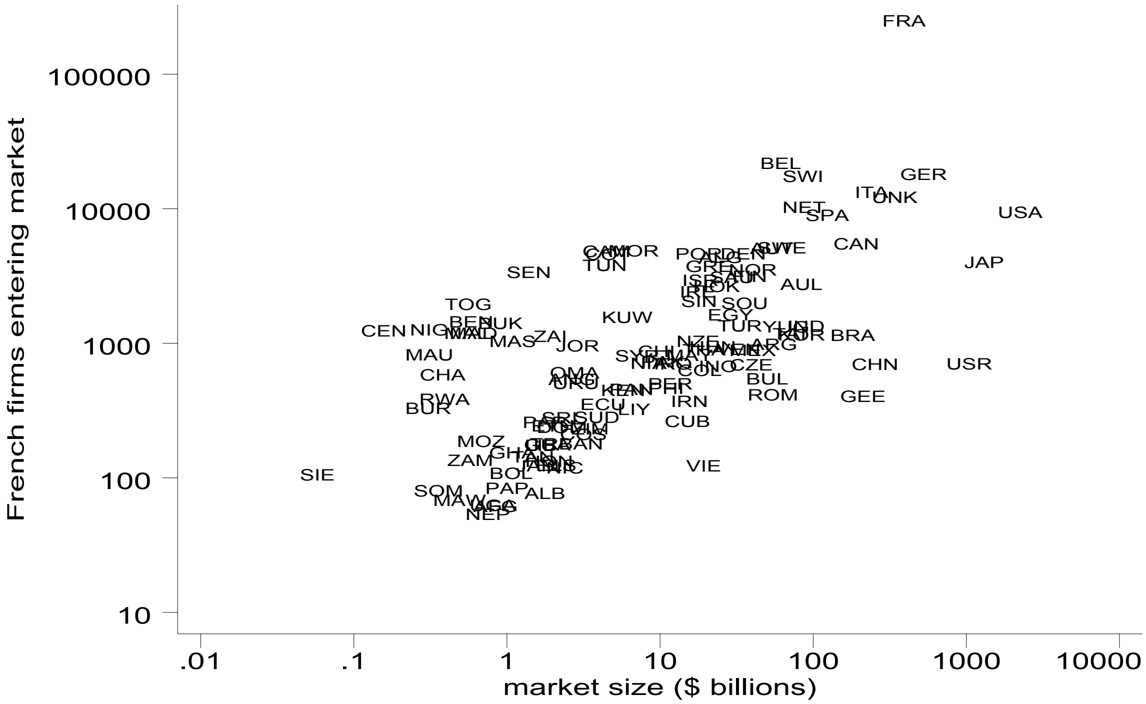


Figure 3: French Firm Entry and Market Size

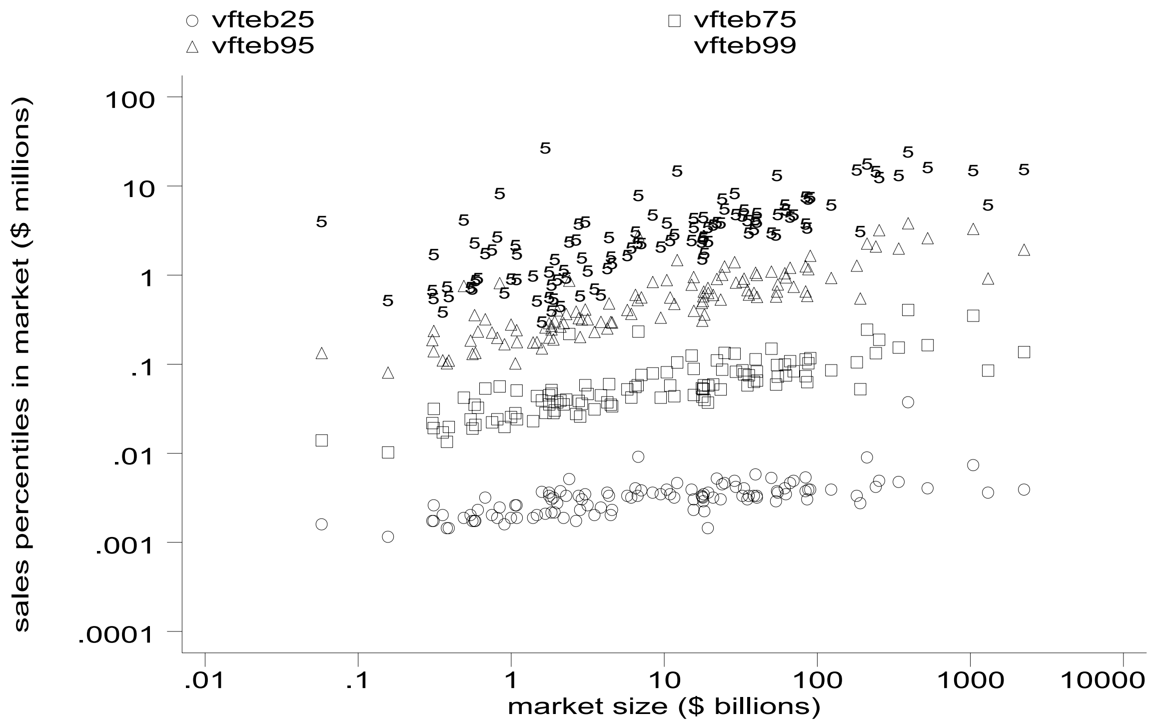


Figure 4: Distribution of Sales by Market

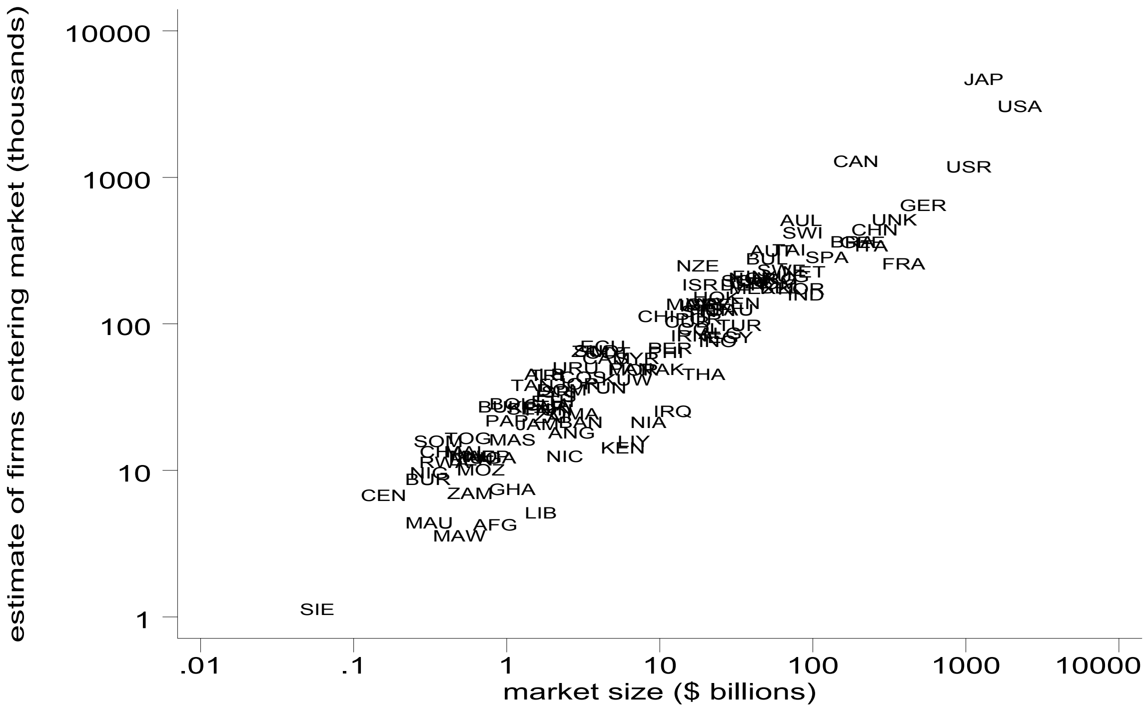


Figure 5: Entry and Market Size

- Double identity:

$$\overline{x}_{nF} J_{nF} \equiv X_{nF} \equiv \pi_{nF} X_n$$

- Systematic relationship among # of French exporters, market size X_n, and French market share in n, π_{nF}:

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

  with $\beta_S = .87$, $\beta_X = .62$ $R^2 = .90$.

- Huge variation in sales among firms exporting to a particular market.

Dissection IV

Run on exporters:

$$\ln X_{nF}(j) = F_j D_j + F_n D_n + u_n(j)$$

$R^2 = .64$.

Country effect only .36; Firm effect only .20 An explanation for superadditivity: Firms that sell a lot tend to sell in smaller countries.

Model

- Account for extreme heterogeneity and fragmented markets but account for striking regularities.

- Approach here: Dixit-Stiglitz preferences encompassing Monopolistic (Melitz, Chaney) or Ricardian (EK) Competition

- Fixed cost of entry per market

Technology

- Countries as sources: $i = 1, ..., N$.

- A wage w_i and a distribution of potential producers with efficiency making good j, z_i a realization drawn from:

$$\Pr[Z_i \leq z] = \exp[-(T_i/J)z^{-\theta}]$$

Trade

- Iceberg unit transport costs: Delivering 1 unit to destination n requires shipping $d_{ni} \geq 1$ from i, with $d_{ii} = 1$.

- Unit cost of delivering good j to market n from i:

$$c_{ni} = \frac{w_i d_{ni}}{z_i(j)}$$

- Distribution of cost in market n:

$$\Pr[C_{ni} \leq c] = 1 - \exp[-(T_i/J)(w_i d_{ni})^{-\theta} c^{\theta}]$$

- Each firm supplying good j to country n incurs a fixed entry cost $E_n(j) = E_n \varepsilon_n(j)$.

- A firm from country i making good j: a realization of the $2N + 1$ vector $\{z_i(j), \alpha_n(j), \varepsilon_n(j)\}$.

- The lowest cost for good j in market n is

$$c_n(j) = \min_i [c_{n1}(j), ...c_{nN}(j)]$$

which will be the realization of a random variable drawn from the distribution:

$$\Pr[C_n \leq c] = 1 - \exp[-(\Phi_n/J)c^\theta]$$

where

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

- Measure of goods that are potentially supplied to country $n$at cost less than c:

$$\mu_n(c) = J\{1 - \exp[-(\Phi_n/J)c^{\theta}]\}$$

- The fraction of firms from country i in market n with costs $C \leq c$ as a share of the total is:

$$\pi_{ni} = \frac{T_i\left(w_i d_{ni}\right)^{-\theta}}{\Phi_n}$$

which will also be the i's trade share in n.

Demand

- Countries as markets: $n = 1, \ldots, N$

- Continuum of goods J.

- Expenditure on good $j$with price $p_n(j)$ in country n:

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

- Price index:

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

A good might j not be available in country n, in which case we think of $p_n(j)^{1-\sigma} = 0$.

Market Structure

- Lowest cost supplier in the market is a monopolist, so will charge the Dixit-Stiglitz mark up:

$$\overline{m} = \frac{\sigma}{\sigma - 1}$$

so that $p_n(j) = \overline{m} c_n(j)$.Bertrand and Cournot competition are more complicated but are able to account for observed differences in measured productivity, as well as the correlations between measured productivity, size, and export participation.

Entry

- Enter if

$$\frac{X_n(j)}{\sigma} \geq E_n \varepsilon_n(j)$$

- or if:

$$\eta_n(j) x_n \geq \left(\frac{\overline{m} c_n(j)}{P_n} \right)^{\sigma - 1}$$

where $x_n = X_n / (\sigma E_n)$ and $\eta_n(j) = \alpha_n(j) / \varepsilon_n(j)$.

- Cutoff $\overline{c}_n(\eta) = \eta^{1/(\sigma-1)} \overline{c}_n$ where $\overline{c}_n = x_n^{1/(\sigma-1)} P_n / \overline{m}$.

Price Index

$$\left(\frac{P_n}{\overline{m}}\right)^{1-\sigma} = E_\eta\left[\int_0^{\bar{c}_n(\eta)} E[\alpha|\eta]c^{1-\sigma}d\mu_n(c)\right].$$

- EK Special Case ($E_n = 0$, $J = 1$)so that all goods are sold and:

$$P_n = \overline{m}\gamma_{EK}\Phi_n^{-1/\theta}$$

- MC Special Case ($J \to \infty$)

$$P_n = \overline{m}\gamma_{MC}\Phi_n^{-1/\theta}x_n^{-[\theta-(\sigma-1)]/[\theta(\sigma-1)]}$$

where $\widetilde{\theta} = \theta/(\sigma - 1)$.

- In general:

$$P_n = \overline{m} \left[\widetilde{P}(x_n) \right]^{-1/(\sigma-1)} \Phi_n^{-1/\theta}$$

where $\widetilde{P}_n$ is the fixed point to:

$$\widetilde{P}_n = E_\eta \left[E[\alpha|\eta] J^{1-1/\widetilde{\theta}} \Gamma \left(1 - 1/\widetilde{\theta}, \frac{\left(\eta x_n / \widetilde{P}_n\right)^{\widetilde{\theta}}}{J} \right) \right]$$

Entry:

$$J_n = J\left(1 - E_\eta\left[\exp\left\{-\left(\eta x_n/\widetilde{P}(x_n)\right)^{\widetilde{\theta}}/J\right\}\right]\right).$$

- As $x_n \to \infty$ (EK) $J_n \to J$.

- As $J \to \infty$ (MC):

$$J_n = \left(1 - 1/\widetilde{\theta}\right) x_n E[\eta^{\widetilde{\theta}}].$$

Summary of the Model's Implications for the Data

- Latent sales by a French firm in market n (sales if it enters):

$$X_n^*(j) = \alpha_n(j) \left(\frac{\overline{m} c_{nF}(j)}{P_n} \right)^{1-\sigma} X_n \tag{1}$$

- Entry hurdle:

$$X_n^*(j) \geq \sigma E_n \varepsilon_n(j), \tag{2}$$

- Competition hurdle:

$$c_{nF}(j) < \widetilde{c}_n(j) = \min_{i \neq F} \{ c_{ni}(j) \} \tag{3}$$

Simulation and Econometric Procedure

- Isolate the stochastic component of $c_{ni}(j)$ by introducing the variable:

$$u_i(j) = (T_i/J)\,(w_i d_{ni})^{-\theta} c_{ni}(j)^{\theta}$$

Our model implies that $u_i(j)$ is drawn from the unit exponential distribution:

$$\Pr[U_i \leq u] = 1 - \exp(-u).$$

- Our competitiveness hurdle in terms of the $u_i(j)$'s and data on trade shares is:

$$u_F(j) < \tilde{u}_n(j) = \min_{i \neq F}\{\pi_{nF} u_i(j)/\pi_{ni}\}.$$

Sales and Entry Cost Shocks

$\alpha_n(j)$ and $\eta_n(j)$ are joint bivariate lognormal:

$$\left[\begin{array}{c} \ln\alpha \\ \ln\eta \end{array}\right] \sim N\left[\left(\begin{array}{c} 0 \\ 0 \end{array}\right), \left(\begin{array}{cc} \sigma_\alpha^2 & \rho\sigma_a\sigma_h \\ \rho\sigma_a\sigma_h & \sigma_h^2 \end{array}\right)\right].$$

Destination Features

Define the vector Γ with representative element:

$$\Gamma_n = \ln(X_n/\widetilde{P}(x_n)) + \widetilde{\theta}^{-1}\ln(X_{nF}/X_n).$$

where $\widetilde{P}(x_n)$ solves:

$$\widetilde{P}(x_n) = \exp\left(\frac{\sigma_a^2(1-\rho^2)}{2}\right) J^{1-1/\widetilde{\theta}} E_\eta\left[\eta^{\rho\sigma_a/\sigma_h}\Gamma\left(1-1/\widetilde{\theta}, \left(\frac{\eta x_n}{\widetilde{P}(x_n)}\right)^{\widetilde{\theta}} J^{-1}\right)\right]$$

Latent Sales

Define $y^*_{1n}(j) = \ln X^*_n(j)$ and ι_N an N-vector of ones, so that:

$$\begin{bmatrix} y^*_1(j) \\ \cdot \\ \cdot \\ y^*_N(j) \end{bmatrix} = \begin{bmatrix} \Gamma_1 \\ \cdot \\ \cdot \\ \Gamma_N \end{bmatrix} - \widetilde{\theta}^{-1} \ln u_F(j) \cdot \iota_N - \widetilde{\theta}^{-1} \ln J \cdot \iota_N + \begin{bmatrix} \ln \alpha_1(j) \\ \cdot \\ \cdot \\ \ln \alpha_N(j) \end{bmatrix}$$

Define $S_n(j) = 1$ if j sells in n and $S_n(j) = 0$ Otherwise. Define $y_n(j) = S_n(j) \ln X_n(j)$ (using our sales data $X_n(j)$).

Conditional on $u_F(j)$ our model is a generalized Tobit.

$$y_n(j) = \begin{cases} y_{1n}^*(j) & \text{if } y_{2n}^*(j) \geq 0 \text{ and } y_{3n}^*(j) \geq 0 \\ 0 \text{ otherwise} \end{cases}$$

where (entry hurdle):

$$\begin{bmatrix} y_{21}^*(j) \\ \cdot \\ \cdot \\ y_{2N}^*(j) \end{bmatrix} = \begin{bmatrix} \Gamma_1 \\ \cdot \\ \cdot \\ \Gamma_N \end{bmatrix} - \widetilde{\theta}^{-1} \ln u_F(j) \cdot \iota_N - \widetilde{\theta}^{-1} \ln J \cdot \iota_N - \begin{bmatrix} \ln \sigma E_1 \\ \cdot \\ \cdot \\ \ln \sigma E_N \end{bmatrix} + \begin{bmatrix} \ln \eta_1(j) \\ \cdot \\ \cdot \\ \ln \eta_N(j) \end{bmatrix}$$

and (competition hurdle):

$$\begin{bmatrix} y_{31}^*(j) \\ \cdot \\ \cdot \\ y_{3N}^*(j) \end{bmatrix} = \begin{bmatrix} \widetilde{u}_1 \\ \cdot \\ \cdot \\ \widetilde{u}_N \end{bmatrix} - u_F(j) \cdot \iota_N,$$

Parameters

- Parameters σ_a^2, σ_h^2, ρ, $\widetilde{\theta}$, J, and, for each country, σE_n

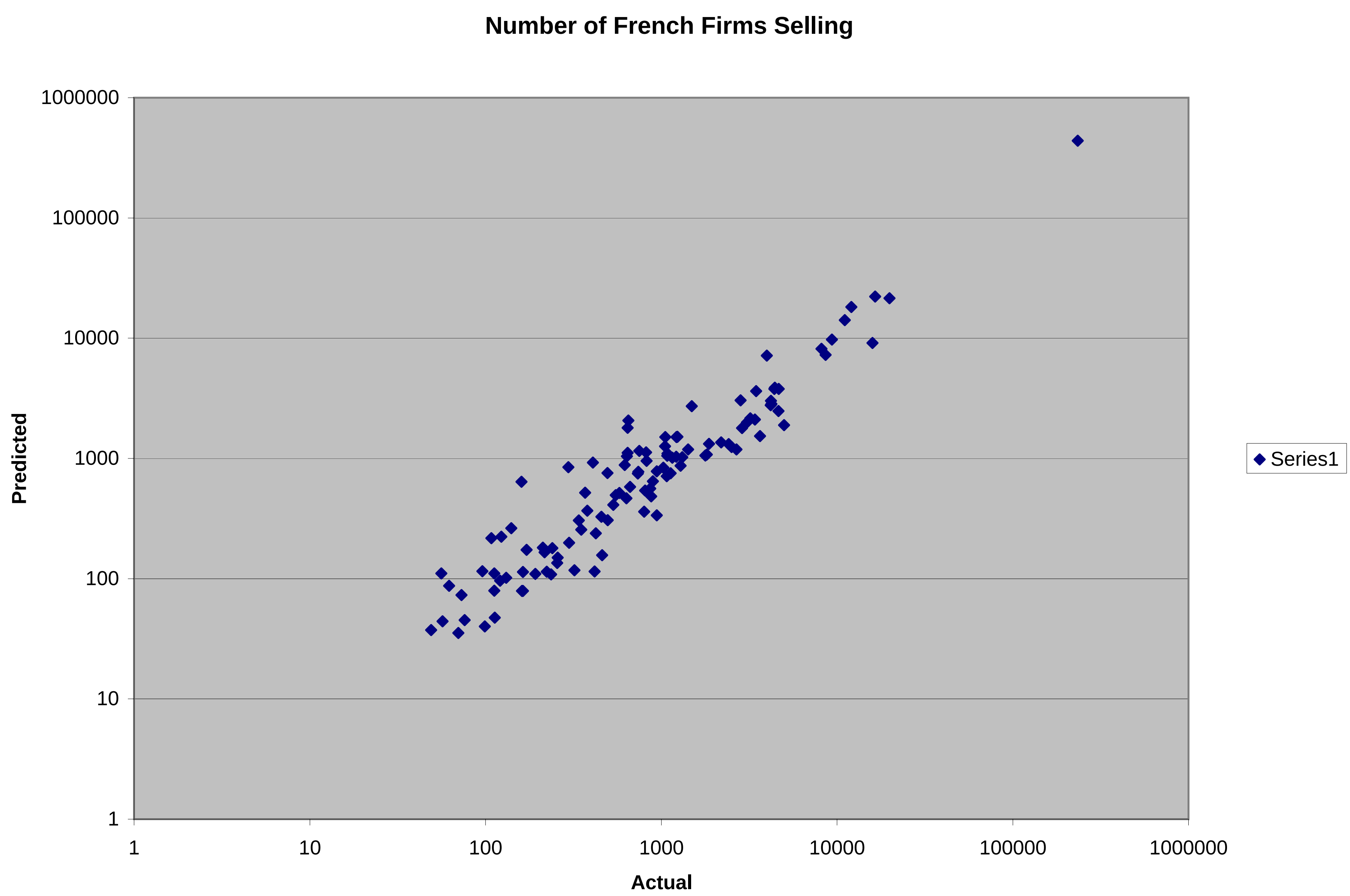
- So far we set $\sigma E_n = \gamma X_n^{\phi}$ and estimate γ and ϕ.:

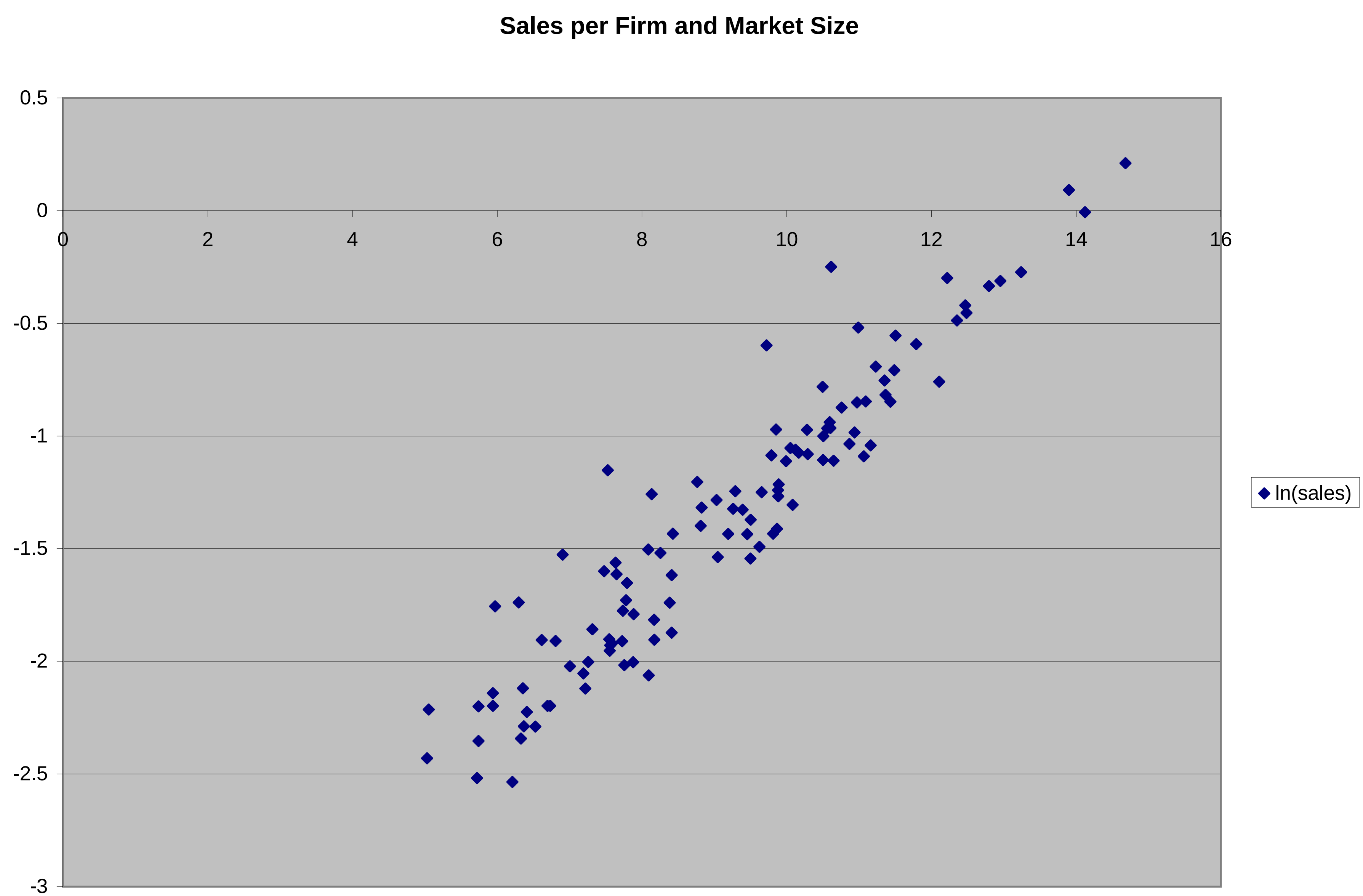
$$\Theta = \begin{pmatrix} \sigma_a^2 & \sigma_h^2 & \rho & \widetilde{\theta} & J & \gamma & \phi \end{pmatrix}'.$$

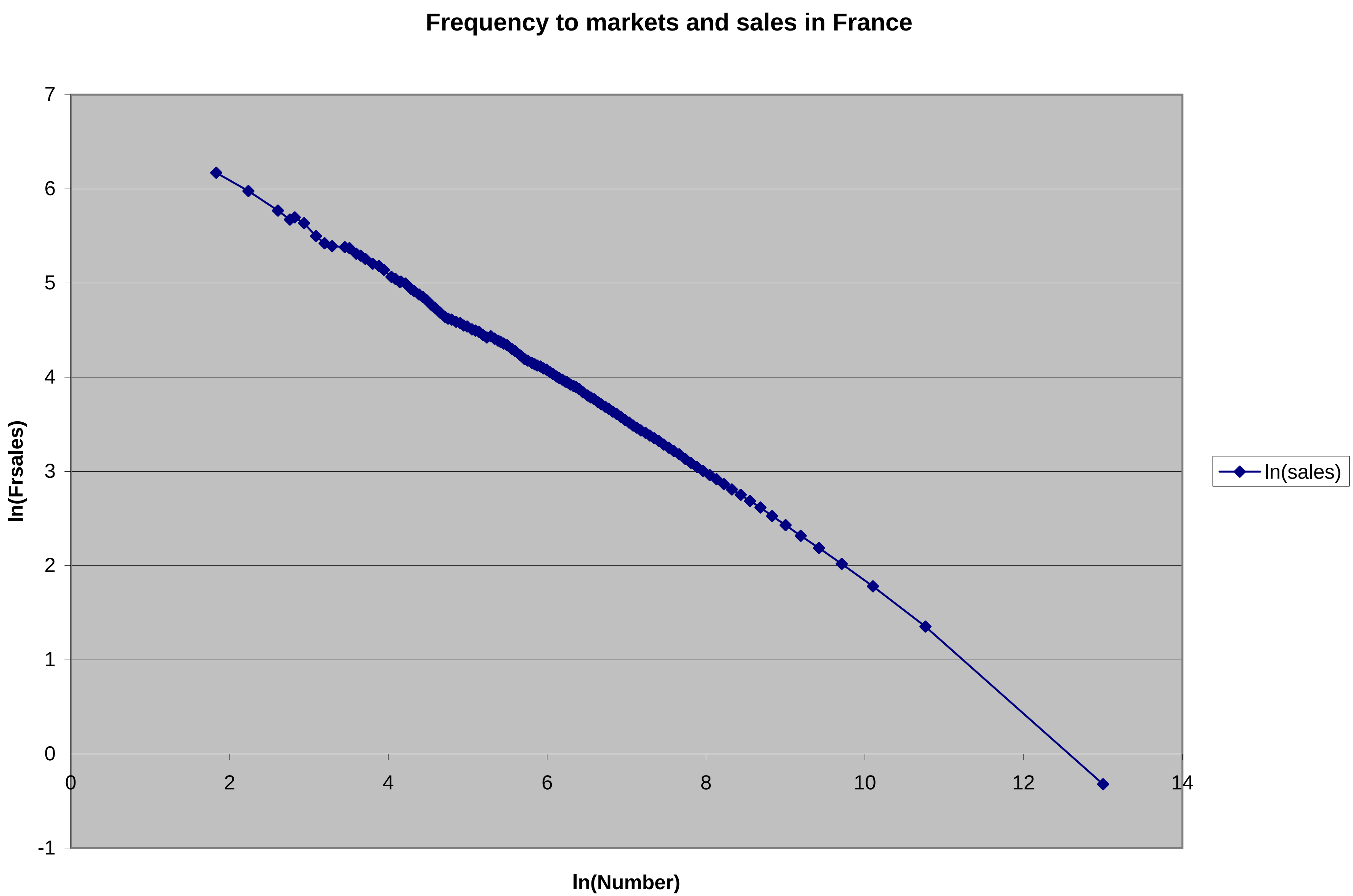
A Simulation Result

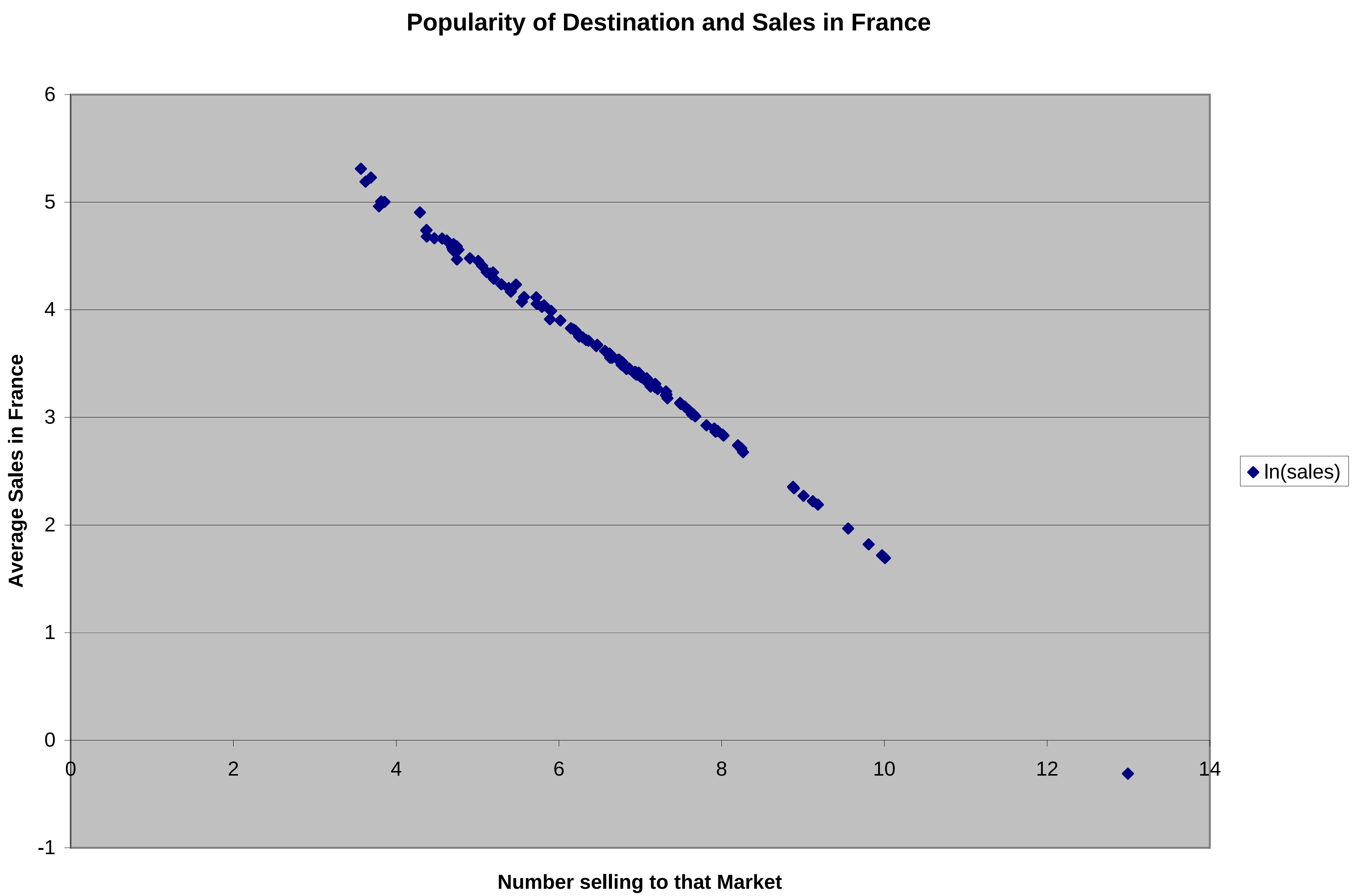
σ_a^2	σ_h^2	ρ	$\widetilde{\theta}$	J	γ	ϕ
1.7708	.6092	$-.4642$	1.7995000	$105,374,370$	.004	.287

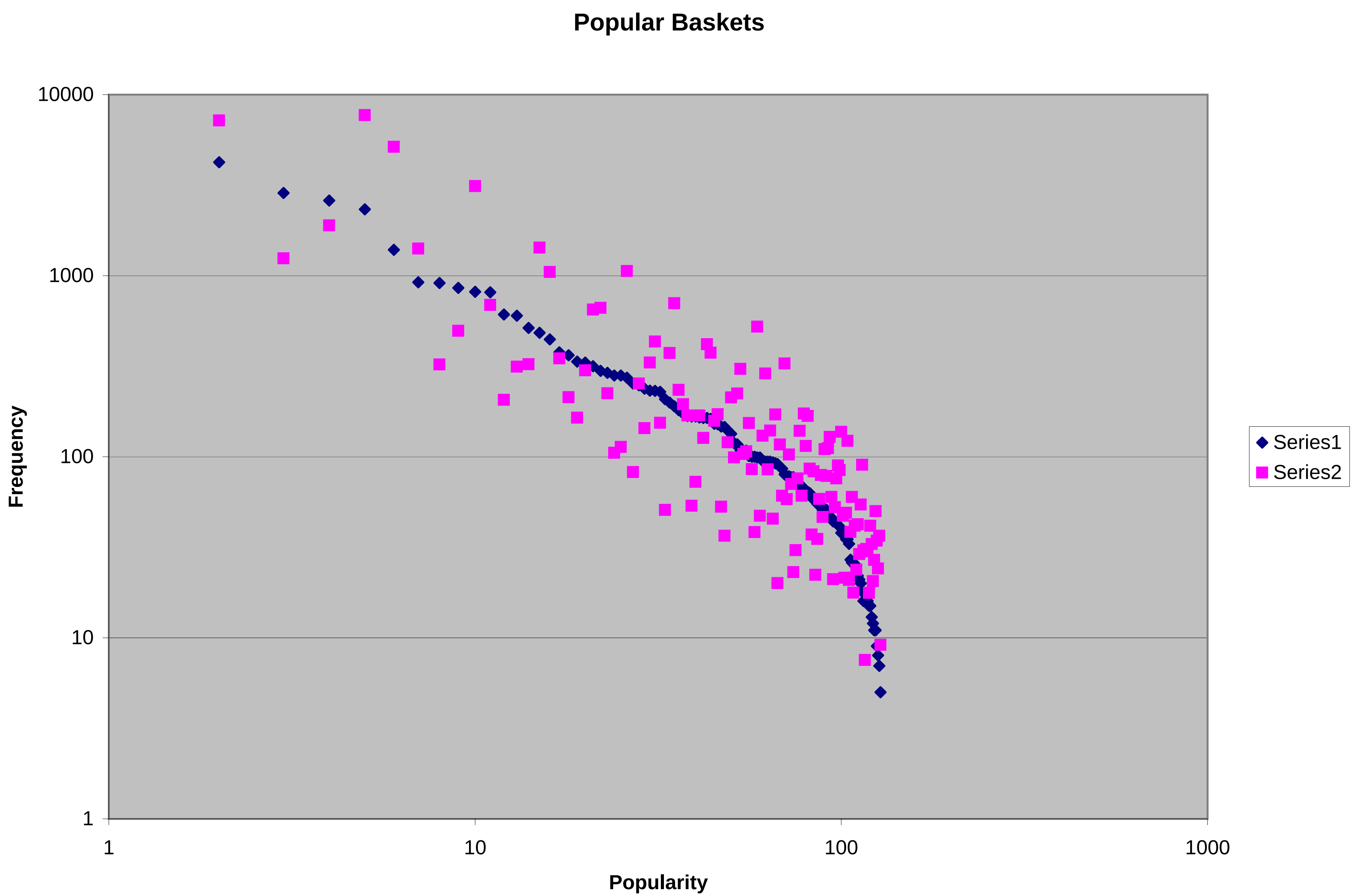
number of simulation draws: 1 million.


Number of French Firms Selling
Predicted
1000000
100000
10000
1000
100
10
1
Actual
1
10
100
1000
10000
100000
1000000
Series1


Sales per Firm and Market Size
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
0
2
4
6
8
10
12
14
16
ln(sales)


Frequency to markets and sales in France
ln(Frsales)
ln(Number)
7
6
5
4
3
2
1
0
-1
0
2
4
6
8
10
12
14
ln(sales)


Popularity of Destination and Sales in France
Average Sales in France
6
5
4
3
2
1
0
-1
0
2
4
6
8
10
12
14
Number selling to that Market
ln(sales)



Popular Baskets
10000
1000
100
10
1
1
10
100
1000
Frequency
Popularity
Series1
Series2