Firm-to-Firm Trade:

Imports, Exports, and the Labor Market

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Agenda

- Use data on French exporters/importers and their wages
- Display the detailed evidence.
- Extend the EKK version of Melitz to look at imports and exports
- Introduce labor markets (wages and employment)
- Combine efficient bargaining with firm export/import behavior
- Relate parameters of the model to the data (preliminary)
Related Literature

• Data: Bernard and Jensen (1995).


A Look at the Data

- Cross-section of 141,000 French manufacturing firms, in 2003
- Approximately 25,000 (20,000) of them export (import from) somewhere.
- Observe exports to (imports from) each of 112 destinations (origins)
- plus wages, employment (by skill-levels), purchases, and sales in France.
- Tables and Figures reveal some striking regularities ...
Exports and Sales in France

Sales in France and Exports

Sales in France and Nbr. of Countries

Sales in France and Nbr. of Importers

Distribution of sales in France

average sales in France

average sales in France

average sales in France

percentile of sales in France

minimum number of countries

# of firms exporting to k or more countries

# of firms exporting to the market

# of firms selling to the market
Distribution of Sales in France by Import Country

- bel
- fra
- ire
- us
Distribution of Wages by Export Market

bel

fra

ire

us

fraction of firms with wage at least that much

Wages in France

1 1.5 2 2.5

0.5

1 1.5 2 2.5

0.5

fraction of firms with wage at least that much

Wages in France

1 1.5 2 2.5

0.5

1 1.5 2 2.5

0.5
Imports and Wages in France

**Wages in France and Imports**

- Average hourly wage in France vs. minimum number of countries.

**Wages in France and Nbr. of Countries**

- Average hourly wage in France vs. number of firms importing from k or more countries.

**Wages in France and Nbr. of Importers**

- Average hourly wage in France vs. number of firms importing from the market.

**Distribution of wages in France**

- Percentile of hourly wage in France vs. number of firms buying from the market.
Exports and Average Hourly Wage
Administrative and commercial managers

Wages and Markets Penetrated

Wages and # Selling to a Market

Number of firms: 30880; Number of exporters: 16556
Imports and Average Hourly Wage

Administrative and commercial managers

Wages and Nbr. of Sourcing Countries

Wages and Nbr. of Sourcing Countries

Wages and # of Importers

Wages and # Selling to a Market

Number of firms: 30877; Number of importers: 15296
Exports and Average Hourly Wage

Technical managers and engineers

Wages and Markets Penetrated

Wages and Markets Penetrated

Wages and # Selling to a Market

Wages and # Selling to a Market

Number of firms: 32757; Number of exporters: 17378
Imports and Average Hourly Wage
Technical managers and engineers

Wages and Nbr. of Sourcing Countries:

- Avg hourly wage in France vs. minimum number of import countries
- Graph showing data points for aggregate and skill group

Wages and Nbr. of Sourcing Countries:

- Avg hourly wage in France vs. # firms buying from k or more markets

Wages and # of Importers:

- Avg hourly wage in France vs. # firms importing from the market

Wages and # Selling to a Market:

- Pile 50- of wage vs. # firms importing from the market

Number of firms: 32752; Number of importers: 16055
Exports and Average Hourly Wage

Skilled blue-collar workers (non-crafts)

Wages and Markets Penetrated

Wages and Markets Penetrated

Wages and # Selling to a Market

Wages and # Selling to a Market

Number of firms: 66673; Number of exporters: 23631
Imports and Average Hourly Wage

Skilled blue-collar workers (non-crafts)

Wages and Nbr. of Sourcing Countries:
- Average hourly wage in France vs. minimum number of import countries
- Graphs showing wage data for aggregate and skill group

Wages and Nbr. of Sourcing Countries:
- Graphs showing average hourly wage vs. number of firms buying from k or more markets

Wages and # of Importers:
- Graphs showing average hourly wage vs. number of firms importing from the market

Wages and # Selling to a Market:
- Graphs showing average hourly wage vs. number of firms selling to a market

Number of firms: 66659 ; Number of importers: 20725
Exports and Average Hourly Wage
Unskilled blue-collar workers (non-crafts)

Number of firms: 58376; Number of exporters: 21749
Imports and Average Hourly Wage
Unskilled blue-collar workers (non-crafts)

Wages and Nbr. of Sourcing Countries:

- Avg hourly wage in France vs. min number of import countries
- Graph showing data points for aggregate and skill group

Wages and Nbr. of Sourcing Countries:

- Avg hourly wage in France vs. # firms buying from k or more markets

Wages and # of Importers:

- Avg hourly wage in France vs. # firms importing from the market

Wages and # Selling to a Market:

- Pile -50% of wage vs. # firms importing from the market

Number of firms: 58365; Number of importers: 19395
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<th>Purchases of Intermediates in France/Total Sales</th>
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<td>0.0115</td>
<td>-0.0365</td>
<td>0.0023</td>
</tr>
<tr>
<td>number of destinations=10</td>
<td>0.0103</td>
<td>0.0159</td>
<td>-0.0233</td>
<td>-0.0011</td>
</tr>
<tr>
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<td>0.0207</td>
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<td>-0.0376</td>
<td>-0.0098</td>
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<tr>
<td>number of destinations=21-50</td>
<td>0.0368</td>
<td>0.0239</td>
<td>-0.0555</td>
<td>-0.0282</td>
</tr>
<tr>
<td>number of destinations&gt;50</td>
<td>0.0436</td>
<td>0.0165</td>
<td>-0.0594</td>
<td>-0.0266</td>
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<tr>
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<td>number of origins=4</td>
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<td>0.0051</td>
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<td>0.0197</td>
</tr>
<tr>
<td>number of origins=5</td>
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<td>0.0000</td>
<td>-0.0048</td>
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</tr>
<tr>
<td>number of origins=6</td>
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<td>0.0027</td>
<td>-0.0008</td>
<td>0.0256</td>
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<tr>
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<td>0.0032</td>
<td>0.0244</td>
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<td>0.0072</td>
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</tr>
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<td>0.0033</td>
<td>-0.0022</td>
<td>0.0158</td>
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<td>number of origins=10</td>
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<tr>
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<td>-0.0300</td>
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<td>-0.0480</td>
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<td>log sales</td>
<td>0.0112</td>
<td>0.0099</td>
<td>0.0189</td>
<td>-0.0018</td>
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<tr>
<td>r2</td>
<td>0.1029</td>
<td>0.1450</td>
<td>0.2596</td>
<td>0.1248</td>
</tr>
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<td>N</td>
<td>141,046</td>
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<td>141,046</td>
<td>141,046</td>
</tr>
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</table>
Lessons from the Data

- Imports and Exports are very similar (parallel?)

- The shapes of the Wage Figures are strikingly similar to those of sales (in EKK), with less variation though

- Both for Exports and Imports

- Firms that export (import) more and more widely pay more

- Firms that serve (are served by) less popular markets pay more

- Firms that sell more in France pay more
Grand Directions of the Model

- Model jointly the Export and Import decisions through a model of Outsourcing

- With Multiple Inputs Coming from France or abroad

- With heterogeneous firms: efficiency and number of skills (complexity)

- Introduce efficient bargaining (McDonald and Solow, 1981) for the labor market

- in an augmented EKK’s version of Melitz.
Elements of the Model: EKK

- Firm \( j \) has efficiency \( z(j) \), same across markets, and a demand shifter \( \alpha_n(j) \) in each destination market \( n \), preferences are CES with \( \sigma > 1 \)

- measure of firms with efficiency above \( z \) is \( \mu^z(z) = Tz^{-\theta} \). (Hence, distribution of costs is proportional to \( c^\theta \))

- charging \( p \) in market \( n \), reaching a fraction \( f \) of consumers, sales in \( n \) are
  \[
x_n(j) = \alpha_n(j) f(j) X_n \left( \frac{p}{P_n} \right)^{-(\sigma-1)}. 
  \]

- with \( l_n(j) \) firm’s employment, \( m_n(j) \) its use of intermediates, output is
  \[
  q_n(j) = z(j) [l_n(j)]^\beta [m_n(j)]^{1-\beta} / d_n
  \]
Then, revenue as a function of $l$, $m$, and $f$ is:

$$x_n(l, m, f) = [\alpha_n(j) f X_n]^{1/\sigma} \left( \frac{z(j) l^\beta m^{1-\beta} P_n}{d_n} \right)^{(\sigma-1)/\sigma}.$$
EKKS: 2-Inputs and Outsourcing (Base Model)

- The production function uses input $0$, cost $w_0$ and has the choice of either labor at cost $w_1$ or an input, at cost $p$.

- Given prices of intermediates $p$, the cost of the input bundle is:

$$b(p) = w_0^{\beta_0} \min \{w_1, p\}^{\beta_1}.$$ 

- The distribution of costs:

$$\mu(c) = \int_0^\infty \mu(c|b(p))dF(p) = Tc^\theta w_0^{-\theta \beta_0} \int_0^\infty \min \{w_1, p\}^{-\theta \beta_1} dF(p)$$
• with $\bar{c}$, largest cost entering, is solution of:

$$\mu(\bar{c}) = \frac{X}{\sigma E} \theta - (\sigma - 1) \frac{\theta}{\theta},$$

• **Extended Model:** The number of suppliers $j$ sampled is distributed Poisson with parameter $\lambda(\bar{c})$, an increasing function of $\bar{c}$. The probability to sample $j$ suppliers is

$$g_j(\bar{c}) = \frac{e^{-\lambda(\bar{c})} [\lambda(\bar{c})]^j}{j!}$$

• If $P_j$ is the price of the lowest cost supplier among these $j$. Its distribution is

$$\Pr[P_j \leq p] = F_j(p) = 1 - [1 - F(p)]^j.$$
• Now, summing over all $j$s:

$$
\mu(c) = T c^\theta w_0^{-\theta} \beta_0 \int_0^\infty \min \{w_1, p\}^{-\theta} \beta_1 e^{-\lambda(\bar{c})} F(p) \lambda(\bar{c}) f(p) dp
$$

• Plugging the Pareto distribution, we have $\mu(c) = \Psi(\bar{c}) c^\theta$ with

$$
\Psi(\bar{c}) = \Phi \left[ \left( \lambda(\bar{c}) \left( \frac{w_1}{\bar{c}} \right)^\theta \right)^{\beta_1} \gamma \left( 1 - \beta_1, \lambda(\bar{c}) \left( \frac{\varpi_1}{\bar{c}} \right)^\theta \right) + \left( e^{-\lambda(\bar{c}) (\varpi_1/\bar{c})^\theta} - e^{-\lambda(\bar{c}) \varpi_1/\bar{c}} \right) \right]
$$

• As a consequence,

$$
\begin{cases}
1 \text{ encounter} & \frac{\partial \mu(c)}{\partial \bar{c}} = 0 \quad \frac{\partial \mu(c)}{\partial \bar{c}} < 0 \\
\text{Poisson } \lambda(\bar{c}) \text{ encounters} & \frac{\partial \mu(c)}{\partial \bar{c}} \geq 0 \quad \frac{\partial \mu(c)}{\partial \bar{c}} \leq 0
\end{cases}
$$
- As long as our choice of $\lambda(\bar{c})$ implies that $\Psi'(\bar{c}) \geq 0$ we are guaranteed that a drop in $E$ increases $\mu(c)$

- The expected number of sales $E(N^s)$, is:

$$E(N^s) = \lambda \exp[-\lambda F(c)]$$

- A more efficient firm is more likely to thrive in an environment with more meetings.
EKKS: Sales with 2-Inputs and Outsourcing

- Expected intermediate sales of a seller in the market with unit cost $c$, equal to the expected number of buyers ($G(c)$ just derived) times expected sales per buyer.

- A buyer has efficiency $Z$ which is distributed: $\Pr[Z \leq z] = 1 - \left( \frac{z}{z(\bar{c})} \right)^{-\theta}$ with $z(\bar{c})$ the lowest efficiency possible for a buyer facing a supplier with cost $c$ ($z = \frac{w_0^\beta e^{\beta_1}}{\bar{c}}$).
• The distribution of expected sales:

\[
\Lambda^M(c) = G(c)\beta_1 \int_{\zeta(c)}^{\infty} \left[ \frac{1}{\bar{m}} \frac{X}{P^{1-\sigma}} \left( \frac{\bar{m}w_0^{\beta_0}c^{\beta_1}}{z'} \right)^{1-\sigma} + \Lambda^M \left( \frac{w_0^{\beta_0}c^{\beta_1}}{z'} \right) \right] \theta [\zeta(c)]^\theta
\]

• All computations done (note the Fixed Point, above) yields:

\[
\Lambda^M = \text{def} \int_0^{\bar{c}} \Lambda^M \left( c' \right) \theta \bar{c}^{-\theta} \left( c' \right)^{\theta-1} dc' = \beta_1 \bar{m}^{-\sigma} \frac{X}{(\sigma-1) P^{1-\sigma}} (\bar{c})^{1-\sigma} \left( 1 - \exp \left[ -\lambda \left( \frac{w_1}{\bar{c}} \right)^\theta \right] \right)
\]

\[
1 - \beta_1 (1 - \exp \left[ -\lambda \left( \frac{w_1}{\bar{c}} \right)^\theta \right])
\]
EKKS: Extension to $K$-Inputs

- The firm samples $j_k$ suppliers for $k = 1, ..., K$, distributed Poisson with a parameter $\lambda(\bar{c})$

$$
\mu(c) = Tc^\theta w_0^{-\theta \beta_0} \prod_{k=1}^{K} \int_0^\infty \min \{w_k, p_k\}^{-\theta \beta_k} e^{-\lambda(\bar{c})F(p_k)} \lambda(\bar{c}) f(p_k) dp_k \\
= \Psi(\bar{c}) c^\theta
$$

- The measure of entrants is

$$
\mu(\bar{c}) = \frac{X \theta - (\sigma - 1)}{\sigma E \frac{\theta}{\theta}},
$$
with expected intermediate sales:

\[ \Lambda^M = \frac{\sum_{k=1}^{K} \beta_k \overline{m}^{-\sigma} \frac{\theta}{\theta-(\sigma-1)} \frac{X}{\theta^{1-\sigma}} c^{1-\sigma} \left( 1 - \exp \left[ -\lambda \left( \bar{c} \left( \frac{\overline{\omega}_k}{\bar{c}} \right) \theta \right) \right] \right)}{1 - \sum_{k=1}^{K} \beta_k \left( 1 - \exp \left[ -\lambda \left( \bar{c} \left( \frac{\overline{\omega}_k}{\bar{c}} \right) \theta \right) \right] \right)} \]
EKKS: Introducing Trade I

- All computations above can be extended to a multiplicity of \( N \) countries, by dividing appropriately by distance \( d_{mn} \) between \( m \) and \( n \).

- For firms in country \( i \):

\[
\psi_i(c_i) = T_i w_{i,0}^{-\theta \beta_0} \prod_{k=1}^{K} \int_0^\infty \min \left\{ w_{i,k}, p_k \right\}^{-\theta \beta_k} e^{-\lambda_i(c_i) F_i(p_k) \lambda_i(c_i) f_i(p_k)} dp_k.
\]

With the associated system of \( N \) equations as:

\[
\frac{X_i}{\sigma E_i} \frac{\theta - (\sigma - 1)}{\theta} = \frac{c_i^\theta}{\sigma} \sum_{l=1}^{N} d_{il}^{-\theta} \psi_l(c_l).
\]
EKKS: Introducing Trade II

- Expected sales are:

\[ \Lambda_n^M(c) = \sum_{k=1}^{K} G_{n,k}(c) \beta_k \bar{c}_n^{-\theta} \sum_{m=1}^{N} d_{mn} \left\{ \frac{\bar{m}^{-\sigma} X_m}{P_m^{1-\sigma}} \frac{\theta}{\theta-(\sigma-1)} \bar{c}_m^{-\theta-(\sigma-1)} \right\} + \int_{0}^{\bar{c}_m} \Lambda_m^M(c'') \theta (c'')^{\theta-1} dc'' \]

- Defining \( \Delta^M = \{ \bar{c}_1^\theta \Lambda_1^M, \bar{c}_2^\theta \Lambda_2^M, ..., \bar{c}_N^\theta \Lambda_N^M \} \)

- \( \tilde{X} = \left\{ \left( \frac{1}{P_1} \right)^{1-\sigma} X_1 \bar{c}_1^{-\theta-(\sigma-1)}, \left( \frac{1}{P_2} \right)^{1-\sigma} X_2 \bar{c}_2^{-\theta-(\sigma-1)}, ..., \left( \frac{1}{P_N} \right)^{1-\sigma} X_N \bar{c}_N^{-\theta-(\sigma-1)} \right\} \)
• **B** an \( N \times N \) matrix with representative element:

\[
b_{nm} = \sum_{k=1}^{K} \beta_k \pi_{nn} (\bar{c}_n)^{-\theta} \left( 1 - \exp \left[ -\lambda_n \left( \frac{\bar{w}_{n,k}}{\bar{c}_n} \right)^\theta \right] \right) (d_{mn})^{-\theta}
\]

• The solution is

\[
\Delta^M = \frac{\theta m^{-\sigma}}{\theta - (\sigma - 1)} [I - B]^{-1} B \tilde{X}
\]
EKKS: Bargaining on Wages and Employment

• The profit resulting from above

\[
\Pi_n(l, m, w, \delta) = x_n^F(l, m, \delta) + x_n^M - w_0 l_{0,n} - \sum_{k=1}^{K} \left[ \delta_k w_k l_{k,n} + (1 - \delta_k) p_k m_{k,n} \right]
\]

• with \( e_{k,n} \) is the overhead labor of type \( k \) to enter market \( n \) implying a fixed cost \( E_n = \sum_{k=0}^{K} w_k e_{k,n} \)

• workers and firm use efficient bargaining and maximize:

\[
\mathcal{L}(l, m, w, \delta) = (1-\gamma) \ln \Pi(l, m, w, \delta) + \gamma \ln \left[ \sum_{k=0}^{K} (w_k - \bar{w}_k) (\delta_k l_k + e_k) \right],
\]
• with $0 \leq \gamma \leq 1$ reflects the bargaining power of workers and $w_k$ type $k$ workers’ reservation wage.

• Notice that we have assumed a status-quo $\pi_0 = 0$ for the firm (to be changed soon).

• **Solutions:** the share of the surplus going to labor;

\[
\sum_{k=0}^{K} (w_k - w_k) (\delta_k l_k + e_k) = \gamma S(l, m, \delta),
\]

• with the rest going to profits

\[
\Pi(l, m, w, \delta) = (1 - \gamma) S(l, m, \delta).
\]
• intermediates purchased:

\[ \delta_k = \begin{cases} 
  1 & w_k \leq p_k \\
  0 & w_k > p_k 
\end{cases} \]

• Finally,

\[ \frac{\partial x_F(l, m, \delta)}{\partial l_k} = w_k. \]

\[ \frac{\partial x_F(l, m, \delta)}{\partial m_k} = p_k \text{ when } w_k > p_k \]
EKKS: Solution for the Wage with $K = 1$

- The solution

$$w(j) = w \left(1 + \frac{\gamma}{(\sigma - 1) \beta}\right) - \gamma w \frac{1 + (\sigma - 1) \beta}{(\sigma - 1) \beta} \sum_n \frac{e_n(j)}{x_n(j)} \frac{l_n(j) + e_n(j)}{l(j) + e(j)}$$

- The appendix shows that the ratio $e_n(j)/x_n(j)$ is increasing in $v_n$ which implies that

$$\frac{e_n(j)}{x_n(j)} \frac{\beta(\sigma-1)}{w \sigma} + \frac{e_n(j)}{x_n(j)}$$

- is also increasing in $v_n$ (as in the data).
Similarly

\[
\frac{x(j)}{l(j) + e(j)} = \sum_n \frac{x_n(j)}{l_n(j) + e_n(j)} \frac{l_n(j) + e_n(j)}{l(j) + e(j)}
= \sum_n \frac{1}{\frac{\beta(\sigma-1)}{w\sigma} + \frac{e_n(j)}{x_n(j)}} \frac{l_n(j) + e_n(j)}{l(j) + e(j)}.
\]

whereas \(\frac{x(j)}{l(j)}\) is equal to a constant
Model Fit: Wage and Exports
Gamma=0.0, Sigma=3, Thetatilde=2.46

Wage and Markets Penetrated
- Minimum number of markets penetrated vs. wage in France
- Data and Model comparison

Wage and Markets Penetrated
- Number of firms selling to k or more markets vs. wage in France
- Data and Model comparison

Wage and # Selling to a Market
- Number of firms selling in the market vs. average wage in France
- Data and Model comparison

Wage and # Selling to a Market
- Number of firms selling in the market vs. median wage in France
- Data and Model comparison
Model Fit: Wage and Exports
Gamma=0.25, Sigma=3, Thetatilde=2.46

Wage and Markets Penetrated
- Minimum number of markets penetrated vs. wage in France
- Data vs. Model

Wage and Markets Penetrated
- Number of firms selling to k or more markets vs. wage in France
- Data vs. Model

Wage and # Selling to a Market
- Number of firms selling in the market vs. average wage in France
- Data vs. Model

Wage and # Selling to a Market
- Number of firms selling in the market vs. median wage in France
- Data vs. Model
Model Fit: Wage and Exports

Gamma=0.50, Sigma=3, Thetatilde=2.46

Wage and Markets Penetrated

Wage and Markets Penetrated

Wage and # Selling to a Market

Wage and # Selling to a Market
Model Fit: Wage and Exports

Gamma = 0.75, Sigma = 3, \( \tilde{Theta} = 2.46 \)

**Wage and Markets Penetrated**

- Wage in France vs. minimum number of markets penetrated
- Data (blue) and Model (red)

**Wage and # Selling to a Market**

- Average wage in France vs. number of firms selling in the market
- Median wage in France vs. number of firms selling in the market
- Data (blue) and Model (red)
Model Fit: Wage and Exports
Gamma=0.99, Sigma=3, Thetatilde=2.46

Wage and Markets Penetrated
- x-axis: minimum number of markets penetrated
- y-axis: wage in France
- Data (blue) vs. Model (red)

Wage and Markets Penetrated
- x-axis: # firms selling to k or more markets
- y-axis: wage in France
- Data (blue) vs. Model (red)

Wage and # Selling to a Market
- x-axis: # firms selling in the market
- y-axis: average wage in France
- Data (blue) vs. Model (red)

Wage and # Selling to a Market
- x-axis: # firms selling in the market
- y-axis: median wage in France
- Data (blue) vs. Model (red)
Sales in France and Wages

$\tilde{\theta} = 2.46; \Sigma = 3$

- **Wages in France**
- **Fraction of firms selling at least that much**

Legend:
- **Blue** $\Gamma = 0.25$
- **Maroon** $\Gamma = 0.50$
- **Green** $\Gamma = 0.75$
- **Orange** $\Gamma = 0.99$
- **Data**
Conclusion

- The EKK model can be “easily extended” to incorporate a parallel treatment of exports and imports.

- It involves the construction of a fixed point (imports are in fact exports of some other foreign firm).

- The model can be further extended to an open economy, multiple inputs, multiple suppliers.

- and firms of different efficiency $z$ and complexity $K$. 
- On the labor market side, adding one bargaining parameter to an export model goes a long way in relating firms’ wages and exports.

- Strong evidence that the Pareto distribution of heterogeneity in sales (efficiency) translates into wages.

- Unobserved individual skills are not accounted for.

- Looks like a promising base for structural estimation.