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


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

minimum number of countries

average sales in France

# of firms exporting to k or more countries

average sales in France

# of firms exporting to the market

average sales in France

# of firms selling to the market

percentile of sales in France
Distribution of Sales in France by Export Country

bel

fra

ire

us

fraction of firms selling at least that much

Sales in France

50 5000 50000

1 2 3 4 5 6 7 8 9 10

fraction of firms selling at least that much

Sales in France

50 5000 50000
Distribution of Sales in France by Import Country

- bel
- fra
- ire
- us

fraction of firms selling at least that much
Sales in France and Imported Intermediate Goods Intensity

- Avg. Foreign Intermediate Goods Use in France
- Fraction of firms selling at least that much in France

Graph showing a decreasing trend as the fraction of firms selling increases in France.
Distribution of Wages by Export Market

bel

fracation of firms with wage at least that much

Wages in France

1 1.5 2 2.5

.5

fra

fracation of firms with wage at least that much

Wages in France

1 1.5 2 2.5

.5

ire

fracation of firms with wage at least that much

Wages in France

1 1.5 2 2.5

.5

us

fracation of firms with wage at least that much

Wages in France

1 1.5 2 2.5

.5
Distribution of Wages by Import Country

bel

frac. of firms with wage at least that much

Wages in France

1 1.5 2 2.5 3

1 1.5 2 2.5 3

frac. of firms with wage at least that much

fra

Wages in France

1 1.5 2 2.5 3

1 1.5 2 2.5 3

frac. of firms with wage at least that much

ire

Wages in France

1 1.5 2 2.5 3

1 1.5 2 2.5 3

frac. of firms with wage at least that much

us

Wages in France

1 1.5 2 2.5 3

1 1.5 2 2.5 3

frac. of firms with wage at least that much
Sales in France and Wages

frac. of firms selling at least that much in France
Imports and Wages in France

Wages in France and Imports

Wages in France and Nbr. of Countries

Wages in France and Nbr. of Importers

Distribution of wages in France

average hourly wage in France

average hourly wage in France

average hourly wage in France

percentile of hourly wage in France

minimum number of countries

# of firms importing from k or more countries

# of firms importing from the market

# of firms buying from the market
Exports and Average Hourly Wage
Administrative and commercial managers

Wages and Markets Penetrated

Wages and Markets Penetrated

Wages and # Selling to a Market

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

Wages and Nbr. of Sourcing Countries

Wages and # of Importers

Wages and # Selling to a 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

Wages and Nbr. of Sourcing Countries

Wages and # of Importers

Wages and # 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

Wages and Nbr. of Sourcing Countries

Wages and # of Importers

Wages and # Selling to a 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>Engineers, Commercial Engineers</td>
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<td>-0.0197</td>
<td>-0.0066</td>
</tr>
<tr>
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<td>-0.0074</td>
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<td>0.0115</td>
<td>-0.0365</td>
<td>0.0023</td>
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<tr>
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<td>0.0103</td>
<td>0.0159</td>
<td>-0.0233</td>
<td>-0.0011</td>
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<tr>
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<td>0.0147</td>
<td>-0.0376</td>
<td>-0.0098</td>
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<tr>
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<td>0.0368</td>
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<td>-0.0282</td>
</tr>
<tr>
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<td>0.0165</td>
<td>-0.0594</td>
<td>-0.0266</td>
</tr>
<tr>
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<td>0.0095</td>
<td>0.0086</td>
<td>-0.0155</td>
<td>0.0028</td>
</tr>
<tr>
<td>number of origins=3</td>
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<td>0.0061</td>
<td>-0.0104</td>
<td>0.0105</td>
</tr>
<tr>
<td>number of origins=4</td>
<td>-0.0024</td>
<td>0.0051</td>
<td>-0.0059</td>
<td>0.0197</td>
</tr>
<tr>
<td>number of origins=5</td>
<td>-0.0011</td>
<td>0.0000</td>
<td>-0.0048</td>
<td>0.0272</td>
</tr>
<tr>
<td>number of origins=6</td>
<td>-0.0088</td>
<td>0.0027</td>
<td>-0.0008</td>
<td>0.0256</td>
</tr>
<tr>
<td>number of origins=7</td>
<td>-0.0057</td>
<td>0.0031</td>
<td>0.0032</td>
<td>0.0244</td>
</tr>
<tr>
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<td>-0.0131</td>
<td>0.0072</td>
<td>0.0129</td>
<td>0.0171</td>
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<tr>
<td>number of origins=9</td>
<td>-0.0097</td>
<td>0.0033</td>
<td>-0.0022</td>
<td>0.0158</td>
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<tr>
<td>number of origins=10</td>
<td>-0.0101</td>
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<td>0.0058</td>
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<tr>
<td>number of origins=11-20</td>
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<td>-0.0115</td>
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</tr>
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<td>-0.0295</td>
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</tr>
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<td>number of origins&gt;50</td>
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<td>-0.0363</td>
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</tr>
<tr>
<td>log sales</td>
<td>0.0112</td>
<td>0.0099</td>
<td>0.0189</td>
<td>-0.0018</td>
</tr>
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</table>

| r2 | 0.1029 | 0.1450 | 0.2596 | 0.1248 |
| N | 141,046 | 141,046 | 141,046 | 141,046 |
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

$$x_n(j) = \alpha_n(j)f(j)X_n\left(\frac{p}{F_n}\right)^{(\sigma-1)}.$$  

• 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:

$$\mu(c) = \int_0^\infty \mu(c|b(p))dF(p) = Tc^\theta w_0^{-\theta_0} \int_0^\infty \min \{w_1, p\}^{-\theta_1} dF(p)$$
• with \( \overline{c} \), largest cost entering, is solution of:

\[
\mu(\overline{c}) = \frac{X}{\sigma E} \left( \frac{\theta - (\sigma - 1)}{\theta} \right),
\]

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

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

• 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

\[
\Psi(\bar{c}) = \Phi \left[ \left( \lambda(\bar{c}) \left( \frac{w_1}{\bar{c}} \right)^\theta \right)^{\beta_1} \gamma \left( 1 - \beta_1, \lambda(\bar{c}) \left( \frac{w_1}{\bar{c}} \right)^\theta \right) + \left( e^{-\lambda(\bar{c})(\bar{w}_1/\bar{c})^\theta} - e^{-\lambda(\bar{c})F(p)} \right) \right]
\]

As a consequence,

\[
\begin{cases}
1 \text{ encounter} & \frac{\partial \mu(c)}{\partial \bar{c}} = 0 \quad \frac{\partial \mu(c)}{\partial \bar{c}} < 0 \\
\text{Poisson } \lambda(\bar{c}) \text{ encounters} & \frac{\partial \mu(c)}{\partial \bar{c}} \geq 0 \quad \frac{\partial \mu(c)}{\partial \bar{c}} \leq 0
\end{cases}
\]

\[
\begin{cases}
w_1 \geq \bar{c} & \frac{w_1}{\partial \mu(c)} \geq \bar{c} \quad \frac{w_1}{\partial \mu(c)} \leq \bar{c} \\
w_1 \leq \bar{c} & \frac{w_1}{\partial \mu(c)} \geq \bar{c} \quad \frac{w_1}{\partial \mu(c)} \leq \bar{c}
\end{cases}
\]
• 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: $\Pr[Z \leq z] = 1 - \left( \frac{z}{z(c)} \right)^{-\theta}$ with $z(c)$ the lowest efficiency possible for a buyer facing a supplier with cost $c$ ($z = \frac{w_0^\beta c^{\beta_1}}{c}$).
• The distribution of expected sales:

\[ \Lambda^M(c) = G(c)\beta_1 \int_{z(c)}^{\infty} \left[ \frac{1}{m} \frac{X}{P^{1-\sigma}} \left( \frac{m \omega_0 c \beta_1}{z'} \right)^{1-\sigma} + \Lambda^M \left( \frac{\omega_0 c \beta_1}{z'} \right) \right] \theta \left[ z(c) \right]^\theta \]

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

\[
\Lambda^M = \text{def} \int_0^{\bar{c}} \Lambda^M \left( c' \right) \theta \bar{c}^{-\theta} \left( c' \right)^{\theta-1} dc' \\
= \frac{\beta_1 m^{-\sigma} \frac{\theta}{\theta-(\sigma-1)} \frac{X}{P^{1-\sigma}} (\bar{c})^{1-\sigma} \left[ 1 - \exp \left[ -\lambda \left( \frac{\omega_1}{c} \right)^\theta \right] \right]}{1 - \beta_1 \left( 1 - \exp \left[ -\lambda \left( \frac{\omega_1}{c} \right)^\theta \right] \right)}
\]
EKKS: Extension to $K$-Inputs

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

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

- The measure of entrants is

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

\[
\Lambda^M = \frac{\sum_{k=1}^{K} \beta_k m^{-\sigma} \frac{\theta}{\theta-(\sigma-1)} \frac{X}{P^{1-\sigma}} \bar{c}^{1-\sigma} \left(1 - \exp \left[-\lambda (\bar{c}) \left(\frac{\bar{\omega}_k}{\bar{c}}\right)^\theta\right]\right)}{1 - \sum_{k=1}^{K} \beta_k \left(1 - \exp \left[-\lambda (\bar{c}) \left(\frac{\bar{\omega}_k}{\bar{c}}\right)^\theta\right]\right)}
\]
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 $i$:

$$\Psi_i(\bar{c}_i) = T_i w_{i,0}^{-\theta \beta_0} \prod_{k=1}^{K} \int_0^{\infty} \min \left\{ w_{i,k}, p_k \right\}^{-\theta \beta_k} e^{-\lambda_i(\bar{c}_i)F_i(p_k)} \lambda_i(\bar{c}_i)f_i(p_k)d p_k.$$  

With the associated system of $N$ equations as:

$$\frac{X_i}{\sigma E_i} \frac{\theta - (\sigma - 1)}{\theta} = \frac{c_i}{\theta} \sum_{l=1}^{N} d_{il}^{-\theta} \Psi_l(\bar{c}_l).$$
EKKS: Introducing Trade II

• Expected sales are:

$$\Lambda_n^M (c) = \sum_{k=1}^{K} G_{n,k} (c) \beta_k \bar{c}_n^{-\theta} \sum_{m=1}^{N} d_{mn}^{-\theta} \left\{ \frac{m^{-\sigma} X_m}{P_1^{1-\sigma} \theta - (\sigma - 1)} \bar{c}_m^{\theta - (\sigma - 1)} + \int_{c_m}^{c_M} \Lambda_m^M (c'') \theta (c'')^{\theta - 1} dc'' \right\}$$

• Defining $\Delta^M = \{ \bar{c}_1^{\theta} \Lambda_1^M, \bar{c}_2^{\theta} \Lambda_2^M, ..., \bar{c}_N^{\theta} \Lambda_N^M \}'$

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

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

• The solution is

$$\Delta^M = \frac{\theta m^{-\sigma}}{\theta - (\sigma - 1)} [I - B]^{-1} B\widetilde{X}$$
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;

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

• 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,

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

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

- The solution

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

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

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

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

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

• 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
- x-axis: minimum number of markets penetrated
- y-axis: wage in France
- Data (blue dots), Model (red dots)

Wage and # Selling to a Market
- x-axis: # firms selling in the market
- y-axis: average wage in France
- Data (blue dots), Model (red dots)
Model Fit: Wage and Exports
Gamma=0.25 , Sigma=3, Thetatilde=2.46

Wage and Markets Penetrated

Wage and # Selling to a Market
Model Fit: Wage and Exports
Gamma=0.50, Sigma=3, Thetatilde=2.46

Wage and Markets Penetrated

Wage and # Selling to a Market
Model Fit: Wage and Exports
Gammar=0.75, 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

Data - Red: Model
Model Fit: Wage and Exports

\[ \text{Gamma}=0.99, \ \text{Sigma}=3, \ \text{Thetatilde}=2.46 \]

Wage and Markets Penetrated

Wage and # Selling to a Market
Sales in France and Wages

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

- $\Gamma = 0.25$
- $\Gamma = 0.50$
- $\Gamma = 0.75$
- $\Gamma = 0.99$
- 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