Quality sorting and trade: Firm-level evidence for French wine

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ES NASM
June 21, 2008
Product quality and export performance

- Why do some firms export more intensively and extensively than others?
- In most recent models the answer is productivity differences.
Product quality and export performance

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We study French wine exports, where we are able to match firm-level flows to firm-level quality ratings from wine guides.
Our contribution

Data 1: “Direct” quality measures compared to “inferred” quality (unit values, market shares)

Data 2: Firm-level quality measures matched to firm-level destination-specific exports

Model: Parameterize model such that Baldwin & Harrigan’s costly quality model can be contrasted with the standard Melitz model.

Method: Predictions tested at firm-level and by relating conditional means to market attractiveness measures.
1. Theoretical predictions for firm-level exports and pricing.
2. Conditional mean predictions: Quality and quantity sorting.
3. Intro to Champagne.
5. Firm-level regression results.
6. Conditional mean figures and regressions.
The model: Demand system

Utility over the set, $B_j$, of all varieties available in country $j$.

$$\begin{align*}
U_j &= \left(\int_\ell \in B_j \left[ s(i) \gamma q(i) \sigma - \frac{1}{\sigma} \right] \right) \frac{1}{\sigma - 1} \\
q(i) &= \text{quantity of variety } i \text{ consumed and } s(i) = \text{measured quality.} \\
\end{align*}$$

Desire for quality is captured in parameter $\gamma$.

$M_j$ individuals with $y_j$ income per capita and an expenditure share on wine given by $\mu_j$.

$$\begin{align*}
x_j(i) &= \left[ p_j(i) \gamma \frac{\tau_j(i)}{s(i)} \right] ^{1-\sigma} \\
\int_\ell \in B_j \left[ p_j(\ell) \gamma \frac{\tau_j(\ell)}{s(\ell)} \right] ^{1-\sigma} d\ell \mu_j y_j M_j / \tau_j(i). \\
\end{align*}$$
The model: Demand system

Utility over the set, $B_j$, of all varieties available in country $j$.

$$U_j = \left( \int_{\ell \in B_j} [s(i)^\gamma q(i)]^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}.$$

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$$x_j(i) = \frac{[p_j(i)\tau_j(i)/s(i)^\gamma]^{1-\sigma}}{\int_{\ell \in B_j} [p_j(\ell)\tau_j(\ell)/s(\ell)^\gamma]^{1-\sigma} d\ell} \mu_j y_j M_j / \tau_j(i).$$
The model: Firms and markets

Standard set of "Krugman" assumptions:
- single factor of production,
- constant marginal costs,
- mill-pricing,
- Dixit-Stiglitz markup,
- iceberg transport costs.

Firm-level heterogeneity:
- Firm \( i \) defined by unit costs, \( \frac{w(i)}{z(i)} \), and quality, \( s(i) \).

Firm/market heterogeneity:
- \( \tau_j(i) - \sigma = \phi_j \eta_j(i) \).

Destination characteristics:
- \( A_j = \mu_j y_m \phi_j P_{\sigma - 1} \).
  - aggregates the determinants of the attractiveness and accessibility of market \( j \).

Profit equation:
- \( \pi_j(i) = \frac{x_j(i)}{\sigma} - F = \left( \frac{z(i)}{w(i)} \right)^{\gamma} A_j \eta_j(i) / \sigma - F \).
The model: Firms and markets

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- Firm-level heterogeneity: Firm $i$ defined by unit costs, $w(i)/z(i)$, and quality, $s(i)$.

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Profit equation:

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\pi_j(i) = \frac{x_j(i)}{\sigma} - F = \left(\frac{z(i)}{w(i)}\right)^{\gamma} s(i)^{\sigma-1} A_j \eta_j(i)/\sigma - F
\]
We follow Baldwin and Harrigan (2007) in assuming a deterministic tradeoff between cost and quality. With \( \lambda \geq 0 \),

\[
\frac{w(i)}{z(i)} = \omega s(i)^\lambda, \tag{1}
\]

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The model: cost-quality tradeoff

- We follow Baldwin and Harrigan (2007) in assuming a deterministic tradeoff between cost and quality.

\[
\frac{w(i)}{z(i)} = \omega s(i)^\lambda, \quad (1)
\]

with \( \lambda \geq 0 \).

- This allows us to compare the results of two cases

1. Quality sorting: \( \gamma > \lambda \geq 0 \)
2. Productivity sorting: \( \gamma = 0, \lambda = -1. \)
Firm-level predictions

Probability firm $i$ exports to market $j$

$$\Pr(\pi_j(i) > 0) = \Pr[\text{cst} + \ln A_j + (\gamma - \lambda)(\sigma - 1) \ln s(i) > -\ln \eta_j(i)]$$

Quantity of exports of firm $i$ to market $j$

$$\ln q_j(i) = \text{cst} + \ln A_j + [(\gamma - \lambda)(\sigma - 1) - \lambda] \ln s(i) + \ln \eta_j(i)$$

Price (fob) charged by firm $i$:

$$\ln p_j(i) = \text{cst} + \lambda \ln s(i)$$
Given $\eta$, solve for critical quality below which entry into market $j$ becomes unprofitable:

$$\hat{s}_j(\eta) = \left( \frac{A_j \eta}{\sigma F \omega^{\sigma-1}} \right)^{-1/(\sigma-1)(\gamma-\lambda)}$$
Entry threshold quality

Given $\eta$, solve for critical quality below which entry into market $j$ becomes unprofitable:

$$\hat{s}_j(\eta) = \left( \frac{A_j \eta}{\sigma F \omega^{\sigma - 1}} \right)^{-1} \left( \frac{1}{(\sigma - 1)(\gamma - \lambda)} \right)$$

$s(i)$ and $\eta_j(i)$ assumed independently distributed
With Pareto distribution of quality ($G(s) = 1 - (s/s_0)^{-\kappa}$):

$$\Pr[\pi_j(i) > 0] = \left( \frac{A_j}{\sigma F \omega^{\sigma - 1}} \right)^{\frac{\kappa}{(\sigma - 1)(\gamma - \lambda)}} s^{\kappa \eta_1}$$

$\eta_1 = a$ moment of the $\eta_j(i)$ distribution, $h(\eta)$

“Popularity” of market $j$: $N_j \approx N_x \Pr[\pi_j(i) > 0]$
Conditional expected quality

- general formula:

\[
E[s \mid \pi_j(i) > 0] = \frac{\int_0^1 \int_{\tilde{s}_j(\eta)}^{\infty} sg(s) h(\eta) ds d\eta}{\Pr[\pi_j(i) > 0]}
\]

- as a function of “attractiveness”:

\[
E[s \mid \pi_j(i) > 0] = \left(\frac{A_j}{\sigma F \omega^{\sigma-1}}\right)^{-1/(\sigma - 1)(\gamma - \lambda)} \frac{\kappa}{\kappa - 1} \left(\frac{\eta_2}{\eta_1}\right)
\]

\(\eta_2\), another moment of \(\eta_j(i)\) distribution.

- as a function of “popularity”:

\[
E[s \mid \pi_j(i) > 0] = (\Pr[\pi_j(i) > 0])^{-1/\kappa} \frac{\kappa}{\kappa - 1} s \eta_2 \eta_1^{(1-\kappa)/\kappa}
\]
## Predicted elasticities

<table>
<thead>
<tr>
<th>model: $s = \cdots$</th>
<th>Expl. var.: $\tilde{s}_j$</th>
<th>Dep. var.: $\tilde{p}_j, \tilde{q}_j$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N_j$ quality pop’y.</td>
<td>$N_j$</td>
<td>$\frac{-1}{\kappa}$</td>
</tr>
<tr>
<td>$\gamma &gt; \lambda \geq 0$</td>
<td>$A_j$ attract.</td>
<td>$\frac{\kappa}{(\sigma-1)(\gamma-\lambda)}$</td>
</tr>
<tr>
<td>$N_j$ prod’y</td>
<td>$N_j$</td>
<td>$\frac{-1}{\kappa}$</td>
</tr>
<tr>
<td>$\gamma = 0, A_j$</td>
<td>$\lambda = -1$</td>
<td>$\frac{\kappa}{\sigma-1}$</td>
</tr>
</tbody>
</table>

$\tilde{s}_j \equiv \left(1/N_j\right) \sum_{i \in H_j} s(i)$ where $H_j$ is set of domestic exporters to $j$
Summary of Model’s Predictions 1

Firm-market level:

1. Probability of exporting and quantity exported should be increasing in quality,
2. Country fixed effects in quantity equation capture $A_j$ (market attractiveness).
3. FOB prices should be increasing in quality, with an elasticity measuring the cost-quality trade-off.
4. Country fixed effects should not explain much of the variance in FOB prices (Dixit-Stiglitz $\implies$ no pricing to market)
Summary of Model’s Predictions II

Market-level means of exporter characteristics

1. Average quality is lower if market $j$ is more “attractive” (high $A_j$) or more “popular” (high $N_j$).

2. Variables that reduce “popularity” (e.g. distance) should increase average quality, and vice-versa (population, income per capita, francophone).

3. Avg. price is lower if $j$ is more “attractive”/“popular.”

4. Avg. quant. is higher if $j$ is more “attractive”/“popular.”

5. Price and quantity elasticities should be equal in absolute value (fragile prediction).

6. Productivity sorting reverses signs of price and quantity effects (fragile prediction).
Focus on Champagne

Champagne has built reputation for non-replicable quality: Armington-style differentiation by place of origin.

Champagne is “wine of kings ... and now the wine for every celebration ... cloaked in glory and prestige ... conveys to the world all that is French elegance and seductiveness” (Hachette Wine Guide)
Firm-level export declarations to French customs.

Observe $x_j(i)$ (euros) and $q_j(i)$ (kilos). Calculate $p_j(i) = x_j(i)/q_j(i)$ (FOB)

8-digit product detail:

- wine is 2204
- sparkling wine is 200410 (hs6)
- champagne is 22041011 (nc8)
Distribution of markets/hs8

Exponential PDF

Champagne
Red Burgundy

Number of destination markets (average per year)
“combination of chalky soil and fickle northern European weather yields sparkling wines that simply can’t be replicated anyplace else” (Steinberger, 2005)

Geographic distinctions within champagne region (a single appellation) are not emphasized.

“[E]ssence of champagne is that it is a blended wine, known in all but a handful of cases by the name of the maker, not the vineyard.” (Johnson and Robinson, 2005)

Quality determined by cellar-master’s talent at blending, “dosing,” etc. Sales policy emphasizes the brand.
Quality measures: concerns and responses

1. *The ratings are expressed in arbitrary units.*
   → Theory includes parameter to measure marginal utility of quality units.

2. *The ratings are unreliable:* idiosyncratic tastes, influence.
   → Use two independent sets of ratings.

3. *The ratings are incomplete:* guides omit bad producers.
   → Infer set of low quality firms and eliminate firms likely to have mixed quality.

4. *The ratings may raised demand by increasing foreign customer awareness.*
   → separate set of regressions using only the French guide ratings (RVF) and restricting the sample to non-francophone markets.
Wine producer quality ratings

- Producers receive 0–3 stars.
- 64 listed producers (51 exporter matches)

- Producers categorized as “average,” “good,” “excellent,” or “outstanding.”
- 70 listed (47 matches)
Champagne quality ratings

<table>
<thead>
<tr>
<th>Parker’s WBG</th>
<th>RVF’s Classement</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Total</th>
</tr>
</thead>
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<td>n/a</td>
<td>n/a</td>
<td>1724</td>
<td>16</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Good</td>
<td></td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Excellent</td>
<td></td>
<td>7</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>0</td>
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<tr>
<td>Outstanding</td>
<td></td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1742</td>
<td>26</td>
<td>14</td>
<td>9</td>
<td>2</td>
</tr>
</tbody>
</table>

Kendall’s $\tau$ measure of concordance $-1 \leq \tau \leq 1$

- All exporters: 0.58 (0.000)
- Included in both books: 0.43 (0.009)
Who exports wine?

Firms classified according to “primary” activity:

- Growers: 011G viticulture (grapes) - 2% 24%
- Vinification: 159F/G - 74% 4%
- Bev. wholesalers: 513J - 7% 62%
- Others: admin., interm., ... - 16% 10%

Some dealers (aka négociants, e.g. Barton & Guestier) mainly label and distribute wine made by other firms. Others (e.g. Faiveley) are vertically integrated backwards into élevage, vinification, and viticulture.
Who exports wine?

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<td>Burg.</td>
</tr>
<tr>
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<tr>
<td>makers</td>
<td>159F/G</td>
<td>vinification (wineries)</td>
<td>74%</td>
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<tr>
<td>others</td>
<td>—</td>
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<td>16%</td>
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|-----------|----------|---------------------------------|--------------|
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| growers   | 011G     | viticulture (grapes)            | 2%           | 24%   |
| makers    | 159F/G   | vinification (wineries)         | 74%          | 4%    |
| dealers   | 513J     | bev. wholesalers                | 7%           | 62%   |
| others    | —        | admin., interm., ...            | 16%          | 10%   |

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### Champagne: # of exporters/destinations

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<td></td>
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<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>grower</td>
<td></td>
<td>40</td>
<td>392</td>
<td>22</td>
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<tr>
<td></td>
<td></td>
<td>76</td>
<td>3972</td>
<td>1015</td>
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<tr>
<td>maker</td>
<td></td>
<td>10</td>
<td>84</td>
<td>33</td>
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<td>5846</td>
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<tr>
<td>dealer</td>
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<td>346</td>
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<td>1624</td>
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<td>769</td>
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<tr>
<td>other</td>
<td></td>
<td>678</td>
<td>101</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2923</td>
<td>1166</td>
<td>824</td>
</tr>
</tbody>
</table>
High/Low/Mixed quality definitions

**High:** Guidebook rates the producer. We map the original rating to a score from 2 to 5.

**Low:** We infer a score of 1 when:
- Omitted from *this* guide but included in the other one or
- Omitted from *both* guides but is (a) grape grower or wine maker and (b) located in the specified growing region.

**Mixed:** Infer no score when
- Grower/maker that is not rated and not local or
- Unrated exporter in any other primary activity (e.g. local unrated dealer)
Markets/firm: Champagne, WBG

Quality Rating
- outstanding
- excellent
- good
- average
- low
- mixed

The graph shows the share of firms exporting to k or more markets, with the number of markets (log scale) on the x-axis and the share of firms exporting to k or more (log scale) on the y-axis. The quality ratings are color-coded, with different markers and line styles indicating the level of quality.
Price (wt. avg.): Champagne, RVF

Price (euros/kg)

mean
mean + std. dev.

mixed
low
included
*
**
***
Price (wt. avg.): Champagne, WBG

<table>
<thead>
<tr>
<th>Quality</th>
<th>Price (euros/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>mixed</td>
<td>mean</td>
</tr>
<tr>
<td>low</td>
<td>mean + std. dev.</td>
</tr>
<tr>
<td>average</td>
<td></td>
</tr>
<tr>
<td>good</td>
<td></td>
</tr>
<tr>
<td>excellent</td>
<td></td>
</tr>
<tr>
<td>outstanding</td>
<td></td>
</tr>
</tbody>
</table>

The bar chart shows the mean and mean + standard deviation for each quality category.

- Mixed: Low
- Low: Mean
- Average: Mean + Standard Deviation
- Good: Mean
- Excellent: Mean
- Outstanding: Mean
Measure of \( s(i) \)

We map book ratings to measured quality, \( s(i) \) as

<table>
<thead>
<tr>
<th>( s )</th>
<th>RVF</th>
<th>Classement 2007</th>
<th>WBG (Parker, 1999)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>In other book OR local maker/grower</td>
<td>“Average” (★★)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Included in RVF</td>
<td>“Good” (★★★)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>★</td>
<td>“Excellent” (★★★★)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>★★</td>
<td>“Outstanding” (★★★★★)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>★★★</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Remaining firms

Firm-level regs average RVF and WBG ratings. We calculate RVF and WBG conditional means separately and then average them.
### Champagne firm-level

<table>
<thead>
<tr>
<th></th>
<th>(1) $q_{jt}(i) &gt; 0$</th>
<th>(2) $\ln p_{jt}(i)$</th>
<th>(3) $\ln q_{jt}(i)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\ln s(i)$</td>
<td>3.61&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.29&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.80&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.01)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>Const.</td>
<td>2.50&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.22&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.03)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>405189</td>
<td>12426</td>
<td>12426</td>
</tr>
<tr>
<td>Within-$jt$ $R^2$</td>
<td>0.117</td>
<td>0.203</td>
<td></td>
</tr>
<tr>
<td>$\rho$: frac. var.</td>
<td>0.38</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td>$\sim$ FE</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Destination-year ($jt$) fixed effects.

Standard errors in parentheses.

Signif:  
- $^c p < 0.1$,  
- $^b p < 0.05$,  
- $^a p < 0.01$
We can reveal structural parameters of the model:

- $\lambda = 0.29$ can be obtained directly from the price regression.
- $\gamma = \lambda + (\beta_{qs} + \lambda)/(\sigma - 1)$. Assuming $5 \leq \sigma \leq 10$, $0.52 \leq \gamma \leq 0.81$
Average quality: Champagne

[Graph showing a scatter plot with countries on the x-axis and conditional mean quality on the y-axis. The graph includes a lowess smoother line with a slope of -0.18 and a GLS line.]

lowess smoother
GLS, slope = −0.18
Average price: Champagne

Conditional Mean Price (euros/kg, log scale)

Number of exporters (log scale)

lowess smoother
GLS, slope = −0.04
Average quantity: Champagne

![Graph showing the relationship between the number of exporters and the average quantity of Champagne exported. The graph includes a lowess smoother and a GLS line with a slope of 0.78.]
Conditional means: Champagne, FE estimate for $A_j$

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\ln N_j$</td>
<td>0.97&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.17&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.07&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.18&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>$\ln \tilde{s}_j$</td>
<td>(0.09)</td>
<td>(0.02)</td>
<td>(0.03)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>$\ln \tilde{p}_j$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\ln \tilde{q}_j$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\ln A_{jt}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>176</td>
<td>176</td>
<td>176</td>
<td>176</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.432</td>
<td>0.470</td>
<td>0.072</td>
<td>0.808</td>
</tr>
</tbody>
</table>

(1): OLS; (2)–(4): GLS, weight<sub>j</sub> = $\sqrt{N_j}$
### Conditional means: Champagne, $A_j$ determinants

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\ln N_j$</td>
<td>$0.40^a$</td>
<td>$-0.07^a$</td>
<td>$0.01$</td>
<td>$0.37^a$</td>
</tr>
<tr>
<td>$\ln \tilde{s}_j$</td>
<td>$0.76^a$</td>
<td>$-0.05^a$</td>
<td>$0.02$</td>
<td>$0.69^a$</td>
</tr>
<tr>
<td>$\ln \tilde{p}_j$</td>
<td>$0.07$</td>
<td>$-0.04^a$</td>
<td>$0.00$</td>
<td>$0.03$</td>
</tr>
<tr>
<td>$\ln \tilde{q}_j$</td>
<td>$-0.04$</td>
<td>$0.01^c$</td>
<td>$-0.00$</td>
<td>$0.01$</td>
</tr>
<tr>
<td>$\ln \text{prodn} (P_j)$</td>
<td>$-0.03$</td>
<td>$0.07^a$</td>
<td>$0.09^a$</td>
<td>$0.10$</td>
</tr>
<tr>
<td>$\ln \text{distance} (\tau_j)$</td>
<td>$-0.03$</td>
<td>$0.07^a$</td>
<td>$0.09^a$</td>
<td>$0.10$</td>
</tr>
<tr>
<td>French ($\tau_j$)</td>
<td>$1.53^a$</td>
<td>$-0.22^a$</td>
<td>$-0.18^a$</td>
<td>$0.61^a$</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>168</td>
<td>160</td>
<td>168</td>
<td>168</td>
</tr>
<tr>
<td><strong>$R^2$</strong></td>
<td>$0.654$</td>
<td>$0.529$</td>
<td>$0.212$</td>
<td>$0.741$</td>
</tr>
</tbody>
</table>

(1): OLS; (2)–(4): GLS, weight$_j = \sqrt{N_j}$
Summary

- Despite imperfections, measured has predictive power.

- Heterogeneous firms theory implies a threshold quality for market entry $\implies$ quality sorting: bad firms squeezed out of difficult markets.

- We show firms with higher measured quality are more likely to export, export more, and charge higher prices.

- Champagne exhibits quality sorting using direct measures.

- Average prices and quantities respond to market attractiveness with the signs predicted by the quality-sorting model.

- Firm-level prices exhibit much destination level variation that is not predicted by the model.