ESTIMATING THE PRODUCTIVITY GAINS FROM IMPORTING

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INTRODUCTION

▶ Large fraction of world trade is accounted for by firms sourcing intermediate inputs from abroad

▶ Trade in inputs benefits domestic consumers:
  ▶ Better quality / new inputs reduce firms’ unit cost
  ▶ This lowers price of domestically produced goods

▶ Question: by how much?

▶ This paper: use theory and microdata to answer that question.
WHAT WE DO

- Study class of firm-based models of importing:
What We Do

- Study class of firm-based models of importing:
  - Heterogeneous firms
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  - Heterogeneous firms
  - CES between domestic and foreign inputs
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- Heterogeneous firms
- CES between domestic and foreign inputs
- Many heterogeneous sourcing countries

Sufficiency result:

Simple formula for aggregate gains from trade
Can be evaluated given the microdata on value added and firms' domestic expenditure shares

Quantitative exercise:

Can a model calibrated to sales data predict the right gains?

Welfare
Study class of firm-based models of importing:

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  - Welfare
RELATED LITERATURE

- Sufficient statistics to evaluate trade policy:
  - Arkolakis, Costinot, Rodriguez-Clare (2012)

- Recent literature on measuring productivity gains from importing:
  - Reduced-form analysis of trade reforms:
  - Structural approach:

- GE model of importing: Antràs, Fort, Tintelnout (2014)
OUTLINE FOR TODAY

1. Firm Problem: Domestic spending and unit costs

2. Embed in Macro Model: Real Wage & Welfare
   2.1 Sufficiency result
   2.2 Bias compared to aggregative model

3. Application to French data:
   3.1 Estimation of trade elasticity
   3.2 Aggregate gains in France
   3.3 Calibration exercise
A Model of Importing: Setup

Production structure

\[
\begin{align*}
y &= \phi k^{\alpha l^{1-\alpha-\gamma}x^\gamma} \\
x &= \left(\frac{\varepsilon^{-1}}{x_D^{\varepsilon}} + \frac{\varepsilon^{-1}}{x_I^{\varepsilon}}\right)\frac{\varepsilon}{\varepsilon-1} \\
x_D &= \eta(q_D, \varphi)z_D \\
x_I &= \left(\int_{c \in \Sigma} (\eta(q_c, \varphi)z_c)^{\frac{\rho-1}{\rho}} dc\right)^{\frac{\rho}{\rho-1}}
\end{align*}
\]

where

- \( q_c \) is country quality
- \( \eta(q, \varphi) \) denotes the firm-specific quality flow
- \( \Sigma \) is the firms’ sourcing strategy

Output market: no restrictions for now // Ext margin: fixed costs to importing
HETEROGENEITY

- Country-level: quality ($q_c$), price ($p_c$) and fixed costs ($f_c$)

- Firm-level: productivity ($\varphi$) and fixed cost ($f_c$)

- This structure nests existing work (Koren, Halpern, Szeidl (2011), Gopinath Neiman (2013))
IMPORTING AND UNIT COST

Unit cost given by:

\[ UC = \frac{1}{\varphi} Q(\Sigma, \varphi)^\gamma r^\alpha W(1-\alpha-\gamma) \]

where

\[ Q(\Sigma, \varphi) = \left( \left( \frac{p_D}{\eta_D} \right)^{1-\epsilon} + A(\Sigma, \varphi)^{1-\epsilon} \right)^{\frac{1}{1-\epsilon}} \]

and

\[ A(\Sigma, \varphi) = \left( \int_{c \in \Sigma} \left( \frac{p_c}{\eta_c(\varphi)} \right)^{1-\rho} dc \right)^{\frac{1}{1-\rho}} \]
IMPORTING AND UNIT COST (Ctd)

- \( Q(\Sigma, \varphi) \) depends on prices, qualities, sourcing strategy...

\[ \text{Exogenous} \times (s_D(\Sigma, \varphi))^{\gamma - 1} \]

\[ \text{PEGains} \times \left( \frac{p_D}{\eta D} \right)^{\gamma r w (1 - \alpha - \gamma)} \]

\[ \text{UC reduction relative to autarky (holding prices fixed) is observable} \]

\[ \text{No assumptions about heterogeneity: quality, prices, productivity} \]

\[ \text{Model for the extensive margin: fixed costs, search, ...} \]

\[ \text{Output structure} \]

\[ \text{Never used CES-structure of the import bundle} \]

\[ \text{Homotheticity: } \eta(\varphi, q) \]

Details
IMPORTING AND UNIT COST (Ctd)

- \( Q(\Sigma, \varphi) \) depends on prices, qualities, sourcing strategy...

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- Hence:

  $$UC = \left( \frac{1}{\varphi} \right) \times \left( s_D(\Sigma, \varphi) \right)^{\frac{\gamma}{\epsilon-1}} \times \left( \frac{p_D}{\eta_D} \right)^{\gamma} \times r^\alpha w^{(1-\alpha-\gamma)}$$

  - Exogenous
  - PE Gains
  - GE

UC reduction relative to autarky (holding prices fixed) is observable

No assumptions about

Heterogeneity: quality, prices, productivity

Model for the extensive margin: fixed costs, search, ...

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Exogenous PE Gains GE

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Aggregation: from Micro to Macro

- Up to now: firm level partial equilibrium unit costs

- To make statements about the aggregate price (real wage)
  - Specify interaction on product markets (“pass through”)
  - Structure of interlinkages across producers (“roundabout production”)

- For welfare:
  - Need to take into account potential resource loss for extensive margin (e.g. fixed costs)
THE BASIC MACRO MODEL

- Measure of monopolistically competitive producers:

\[
y_i = \phi_i l_i^{1-\gamma} x_i^\gamma
\]

\[
x_i = \left(\frac{\varepsilon-1}{x_{Di}^\varepsilon} + \frac{\varepsilon-1}{x_{Ii}^\varepsilon}\right)^{\frac{\varepsilon}{\varepsilon-1}}
\]

- Perfectly competitive final good producer:

\[
Y = \left(\int \frac{\varepsilon-1}{\sigma} y_i^\frac{\varepsilon-1}{\sigma} di\right)^{\frac{\sigma}{\sigma-1}}
\]

- Perfectly competitive domestic input producer:

\[
X_D = Ml_D^\phi Y_X^{1-\phi}
\]
Fixed costs in units of labor

To close aggregate economy
  - impose balanced trade
  - exports in terms of the final good

Assume exogenously given labor supply of $L$
The domestic price $P$ and the gains from trade (rel. to autarky) are given by

$$
\frac{1}{P} = \left( \int_{i=0}^{1} \left[ \phi_i s_{Di}^{\frac{\gamma}{1-\varepsilon}} \right]^{\sigma-1} di \right)^{\frac{1}{\sigma-1}} \frac{1}{1-(1-\phi)\gamma}
$$

$$
G \equiv \frac{P^{Aut}}{P} = \left( \int_{i=0}^{1} \left( \frac{\phi_i^{\sigma-1}}{\int_{i=0}^{1} \phi_i^{\sigma-1} di} \right) s_{Di}^{\frac{\gamma(\sigma-1)}{1-\varepsilon}} di \right)^{\frac{1}{\sigma-1}} \frac{1}{1-(1-\phi)\gamma}
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\]

- Require joint distribution of $\phi$ and $s_D$
A Sufficiency Result

- With micro-data on value added and domestic shares, we can identify innate productivity $\varphi$ up to scale

$$\nu a = \kappa \times \left( \varphi S_D^{\frac{\gamma}{1 - \varepsilon}} \right)^{-\frac{1}{\sigma}}.$$

- Gains from trade

$$G = P_{Aut} - P = \left( \int v_i \int v_i ds \right)^\gamma \left( 1 - \varepsilon \right) \left( 1 - \sigma \right).$$

- Fully determined from micro-data given parameters $(\varepsilon, \gamma, \sigma)$

- Any model in the above class will have the same gains $G$

- In particular: extensive margin does not matter (given the data!)
With micro-data on value added and domestic shares, we can identify innate productivity \( \varphi \) up to scale

\[
va = \kappa \times \left( \varphi S_D^\frac{\gamma}{1-\varepsilon} \right)^{\sigma-1}.
\]

Gains from trade

\[
G = \frac{P^{Aut}}{P} = \left( \int \frac{va_i S_D^\gamma (1-\sigma)}{\int va_i di}^\frac{1-\varepsilon (1-\sigma)}{1-\sigma} di \right)^{\frac{1}{1-\sigma}}
\]
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IMPORTANCE OF MICRO-DATA

- How important is the micro-heterogeneity?
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- Formula gives a simple answer:

\[
\ln \left( \frac{P_{Aut}}{P} \right) = \frac{\gamma}{1 - \varepsilon} \ln (\lambda^D) + \frac{1}{1 - \sigma} \ln \left( \int \frac{v_{ai}}{\lambda^D} \int v_{ai} \, di \right) \left( \frac{s_{Di}}{\lambda^D} \right)^{\frac{\gamma}{1 - \varepsilon} (1 - \sigma)} \left( 1 - \sigma \right) \right).
\]

Agggregate Data  Bias

- Can evaluate directly from micro-data
- Crucial dimensions:
  - cross-sectional dispersion of domestic shares
  - correlation between domestic shares and firm-size
- Note: Bias can be positive or negative
  - \( \text{Bias} > 0 \iff \sigma > 1 + \varepsilon - 1 \gamma \)
- Also: \( \varepsilon \) estimated from firm-level data is lower than aggregate trade elasticity.
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HOW IMPORTANT IS THE MICRO-HETEROGENEITY?

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Aggregate Data + Bias

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- Also: \( \varepsilon \) estimated from firm-level data is lower than aggregate trade elasticity
WELFARE

- Welfare is given by

\[
U = \left(1 + \frac{1}{\sigma - 1} \left(1 - \gamma + \gamma \phi \lambda^D \right)^{-1}\right) \times \frac{w}{P} \times (L - L_F)
\]

where \(L_F\) is resource loss of firms’ extensive margin

- Need to actually solve for firms’ sourcing strategies
Extensive Margin with Fixed Costs of Sourcing

Optimal sourcing strategy solves

$$\pi(\varphi, [f]) = \max_{\Sigma, y, l} \left\{ py - \Gamma(\Sigma, y, \varphi, l) - wl - w \sum_{c \in \Sigma} f_c \right\}$$

where $\Gamma(\Sigma, y, \varphi, l)$ is cost function

Problem:

- Complementarities introduce interdependence across markets ($\neq$ export problem, e.g. EKK).
- If $f_c$ and $q_c$ both vary by country, need to compare all sourcing strategies.
EXTENSIVE MARGIN: TRACTABILITY

- To make progress, impose more assumptions:

  1. Fixed costs are constant across countries
     \[ \sum \] reduces to cut-off \( q \) (or share of countries \( n \))
  
  2. Other simplifying assumptions:
     - Homothetic demand: \( \eta(q, \phi) = q \)
     - Distribution of qualities is Pareto: \( G(q) = 1 - (q_{\min} / q) \theta \)
     - Prices are given by: \( p_c = \alpha q^\nu_c \)
     - Implication: Firm-specific price index 
     \[ A(\sum, \phi) - 1 = \zeta n \eta \]
     - \( \eta \) and \( \zeta \) depend on structural parameters (\( \rho, \theta, q_{\min}, \nu \))
     - can directly be estimated from micro-data

Details
EXTENSIVE MARGIN: TRACTABILITY

- To make progress, impose more assumptions:
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   - Prices are given by:
     $$p_c = \alpha q_c^\nu$$

- Implication: Firm-specific price index
  $$A(\Sigma, \varphi)^{-1} = zn^\eta$$

- $\eta$ and $z$ depend on structural parameters ($\rho, \theta, q_{\text{min}}, \nu$)
- can directly be estimated from micro-data
Empirical Application

- Application to French micro data
  - population of manufacturing firms
  - customs data matched to fiscal data at firm-level

- Procedure
  - Step 1: Estimate \((\epsilon, \gamma)\) from micro data
  - Step 2: Use micro-data and sufficiency result to quantify gains and bias
  - Step 3: Calibrate firm-based model
    - requires extensive margin
Estimating the “trade elasticity” $\varepsilon$

$$y = \phi s_D^{\frac{\gamma}{1-\varepsilon}} l^\alpha k^\beta X^\gamma$$

Estimate in two stages

1. Estimate productivity residual from

   $$\ln(S) = \tilde{\alpha} \ln(k) + \tilde{\beta} \ln(l) + \tilde{\gamma} \ln(x) + \ln(\vartheta)$$

2. Decompose $\ln(\vartheta)$ into trade and innate component

   $$\Delta \ln(\vartheta) = -\frac{\tilde{\gamma}}{\varepsilon - 1} \Delta \ln(s^D) + \Delta \ln(\varphi)$$

   instrumenting $s^D$ with firm-specific supply shocks (Hummels, et. al. 2014)

   $$Z_{it} = \sum_{ck} \Delta W E S_{ckt} \times s_{cki}^{pre}$$
**Estimating ε: Results**

\[ \Delta \ln(\hat{\theta}_{ist}) = \delta_s + \delta_t + \frac{1}{1 - \varepsilon} \times \Delta \tilde{\gamma}_s \ln(s_{ist}^D) + u_{ist} \]

<table>
<thead>
<tr>
<th></th>
<th>First Stage</th>
<th>Baseline</th>
<th>IV Estimate Importers in 2001</th>
<th>Balanced Panel</th>
</tr>
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<tbody>
<tr>
<td>( \Delta WES )</td>
<td>-0.010***</td>
<td>-0.741**</td>
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<td>Implied ( \varepsilon )</td>
<td>2.35</td>
<td>2.83</td>
<td>2.55</td>
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<tr>
<td></td>
<td>(0.648)</td>
<td>(1.087)</td>
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<tr>
<td>( N )</td>
<td>67,696</td>
<td>67,696</td>
<td>58,027</td>
<td>48,480</td>
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<tr>
<td>( R^2 )</td>
<td>0.00</td>
<td>0.265</td>
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THE GAINS FROM TRADE IN FIRM-BASED MODELS OF IMPORTING

- Measure aggregate gains as

\[ G = \sum_k VA_k G_k \]

where

\[ G_k = \left( \int \frac{va_{ik}}{va_{ik} di} s_{Dik} \frac{\gamma_k}{1-\epsilon} (1-\sigma) \right)^{\frac{1}{\sigma-1}} \]

Result

Micro Data = 13%

Aggregate Data = 11.9%

Bias = 13% - 11.9% = 9%

Wide class of firm-based models of importing will arrive exactly at this number if successfully calibrated to the micro-data.
The Gains from Trade in Firm-Based Models of Importing

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- ... if successfully calibrated to the micro-data

Micro Gains
The Size of the Bias

**Figure**: Bootstrap Distribution of the Bias

- Confident that bias is between 8% and 9.5%
Calibrating the Macro Model

Strategy:

1. Use estimated parameters \((γ, ε, η)\) from above Estimate \(η\)

2. Calibrate heterogeneity in productivity and fixed costs

\[
\begin{pmatrix}
\ln(ϕ) \\
\ln(f)
\end{pmatrix}
\sim
\mathcal{N}
\begin{pmatrix}
\mu_ϕ \\
\mu_f
\end{pmatrix}
\begin{pmatrix}
\sigma_ϕ^2 & \rho σ_ϕ σ_f \\
ρ σ_ϕ σ_f & σ_f^2
\end{pmatrix}
\]

3. Comparison:

3.1 Matching features of joint distribution of \(s_D\) and sales

3.2 Calibrate to sales data only
The Joint Distribution of Firm Size and Import Intensity

Figure: Micro gains and firm size
## Calibration: Results

<table>
<thead>
<tr>
<th>Target Moments</th>
<th>French Data</th>
<th>Model</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate Domestic Share</td>
<td>0.71</td>
<td>0.71</td>
<td>$\mu_f = 9.05$</td>
</tr>
<tr>
<td>Share of Importers</td>
<td>0.32</td>
<td>0.32</td>
<td>$f^I = 0.003$</td>
</tr>
<tr>
<td>Dispersion in Domestic Shares (Importers)</td>
<td>0.27</td>
<td>0.26</td>
<td>$\sigma_f = 3.26$</td>
</tr>
<tr>
<td>Dispersion in log Sales (Importers)</td>
<td>1.63</td>
<td>1.62</td>
<td>$\sigma_\varphi = 1.01$</td>
</tr>
<tr>
<td>Correlation log Sales - Dom Shares (Importers)</td>
<td>-0.01</td>
<td>-0.01</td>
<td>$\rho = 0.41$</td>
</tr>
</tbody>
</table>
# The Importance of Domestic Shares

<table>
<thead>
<tr>
<th></th>
<th>Baseline Model</th>
<th>Baseline Parameter</th>
<th>No $s_D$ Data Model</th>
<th>No $s_D$ Data Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate Domestic Share</td>
<td>0.71</td>
<td>$\mu_f = 9.05$</td>
<td>0.71</td>
<td>$\mu_f = 5.19$</td>
</tr>
<tr>
<td>Dispersion in log Sales</td>
<td>1.62</td>
<td>$\sigma_\phi = 1.01$</td>
<td>1.63</td>
<td>$\sigma_\phi = 1.72$</td>
</tr>
<tr>
<td>Share of Importers</td>
<td>0.32</td>
<td>$f^l = 0.003$</td>
<td>0.32</td>
<td>$f^l = 8.8e^{-05}$</td>
</tr>
<tr>
<td>Dispersion in Domestic Shares</td>
<td>0.26</td>
<td>$\sigma_f = 3.26$</td>
<td>0.09</td>
<td>$\sigma_f = 0$</td>
</tr>
<tr>
<td>Correlation log Sales - Dom Shares</td>
<td>-0.01</td>
<td>$\rho = 0.41$</td>
<td>-0.76</td>
<td>$\rho = 0$</td>
</tr>
<tr>
<td>Real Wage Gains</td>
<td>15.46%</td>
<td></td>
<td>12.94%</td>
<td></td>
</tr>
<tr>
<td>Welfare Gains</td>
<td>16.46%</td>
<td></td>
<td>13.73%</td>
<td></td>
</tr>
</tbody>
</table>

Ignoring micro data on domestic shares lowers predicted gains from trade by 16.3% (Real Wage) and 16.6% (Welfare).

For comparison: ACR-type gains: $0.71 \gamma/(1-\varepsilon) = 12.5\%$
**Source of Bias**

“Different models may lead to different magnitude of the gains from trade, because they predict different counterfactual autarky equilibria” (CRC, 2014)
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“Different models may lead to different magnitude of the gains from trade, because they predict different counterfactual autarky equilibria” (CRC, 2014)

▶ Here: predict productivity $\varphi$ from sales and $s_D$

$$\text{var}(\ln(\text{Sales})) = \sigma^2_\varphi + \left(\frac{\gamma}{\varepsilon - 1}\right)^2 \sigma^2_{SD} - 2\frac{\gamma}{\varepsilon - 1} \text{cov}(\log(\varphi), \log(s_D))$$

▶ Two types of biases:

1. Too little dispersion in domestic shares $\rightarrow$ Too much variance in $\varphi$ $\rightarrow$ Gains are downward biased
2. Too strong a negative correlation between $\varphi$ and $s_D$ $\rightarrow$ Too little variance in $\varphi$ $\rightarrow$ Gains are upward biased
SOURCE OF BIAS

“Different models may lead to different magnitude of the gains from trade, because they predict different counterfactual autarky equilibria” (CRC, 2014)

► Here: predict productivity $\phi$ from sales and $s_D$

$$\text{var}(\ln(\text{Sales})) = \sigma^2_{\phi} + \left(\frac{\gamma}{\varepsilon - 1}\right)^2 \sigma^2_{SD} - 2\frac{\gamma}{\varepsilon - 1} \text{cov}(\log(\phi), \log(s_D))$$

Dispersion Bias

Correlation Bias

► Two types of biases:

1. Too little dispersion in domestic shares $\rightarrow$ Too much variance in $\phi$ $\rightarrow$ Gains are downward biased

2. Too strong a negative correlation between $\phi$ and $s_D$ $\rightarrow$ Too little variance in $\phi$ $\rightarrow$ Gains are upward biased

► In our case: dispersion effect dominates

$$\sigma^\text{Full}_\phi = 1.01 < 1.72 = \sigma^\text{NSD}_\phi$$
Marginal Distributions

Fraction of firms (in 100 bins of equal length)

Domestic share, importers

In(Sales), importers

French data     Baseline   No domestic share data

Note: the distributions of ln(sales) have been normalized to have a mean of 1
CONCLUSIONS

- Wide class of models: domestic spending shares fully capture UC reductions through sourcing

- Micro-data on value added and domestic shares fully determine the macro gains from trade in non-aggregative environment
  - robust across models
  - aggregate statistic gives biased answer of 9%

- Source of bias:
  - domestic shares are required to identify physical productivity
  - physical productivity is required to predict counterfactual allocations in autarky

- Puts discipline on quantitative models of importing and useful for applied work
Appendix
RELATION TO EXISTING PAPERS

This framework encompasses most of the existing papers, e.g.

   - Homothetic demand: \( \eta (q, \varphi) = q \)
   - Single outside country: \( \rho \to \infty \) and \( G_k (q) \) degenerate
   - No quality/price differences between products: \( q_k / p_k = A \)
   - Equal fixed costs (plus firm-specific noise): \( f_{ck} = f \times u \) where \( u \) is firm-specific

2. Gopinath Neiman (2013)
   - Homothetic demand: \( \eta (q, \varphi) = q \)
   - No distinction between products and countries
   - All countries are alike: \( G_k (q) \) degenerate
   - Constant fixed costs across firms (\( f \times n^\lambda \))

   We show direct evidence on
   - Substantial dispersion in quality: \( G (q) \) not degenerate
   - Importance of complementarities: \( \rho < \infty \)
Useful to solve the firms’ problem in 2 steps:

\[ \pi(\varphi, f) \equiv \max_{\Sigma, y, l, k} \left\{ py - \Gamma(\Sigma, y, \varphi, k, l) - wl - rk - w \left( \int_{c \in \Sigma} f_c dc + f_l I(\Sigma) \right) \right\} \] (1)

\[ \Gamma(\Sigma, y, \varphi, k, l) \equiv \min_{z} \left\{ \int_{c \in \Sigma} p_c z_c dc \text{ s.t. } \varphi k^{\alpha} l^{1-\alpha} x^\gamma \geq y \right\} \] (2)

where

- (2) → intensive margin
- (1) → extensive margin

Note:

- (1) is hard and requires strong assumptions
- (2) can be characterized without additional assumptions

Key: (2) is all we need to measure effect of trade on unit cost
Given $\Sigma$, solve for optimal import demand

1. Letting $m$ be import spending:

$$\frac{x_I}{m} = A(\Sigma, \varphi) = \left( \int_{c \in \Sigma} \left( \frac{\eta(q_c, \varphi)}{p_c} \right)^{\rho-1} dc \right)^{\frac{1}{\rho-1}}$$

2. Letting $X$ be total intermediary spending:

$$x = \left( \left( \frac{\eta(q^D, \varphi)}{p_D} \right)^{\varepsilon-1} + A(\Sigma, \varphi)^{\varepsilon-1} \right)^{\frac{1}{\varepsilon-1}} X$$

$$\equiv Q(\Sigma, \varphi) X$$

Note:

- $\Sigma$ affects $A$ and $Q$
- $\varphi$ only matters through $\eta(., \varphi)$
**Intensive Margin (ctd)**

We showed:

\[ x = A(\Sigma, \varphi) m \]

Domestic vs foreign trade-off:

\[ s_D = \frac{p_D z_D}{X} = \frac{(\eta (q_D, \varphi) / p_D)^{\varepsilon - 1}}{(\eta (q_D, \varphi) / p_D)^{\varepsilon - 1} + A(\Sigma, \varphi)^{\varepsilon - 1}} \]

And:

\[ x = \left( x_D^{\varepsilon - 1} + x_I^{\varepsilon - 1} \right)^{\varepsilon \over \varepsilon - 1} = Q(\Sigma, \varphi) X \]

where

\[ Q(\Sigma, \varphi) \equiv \left( (\eta (q_D, \varphi) / p_D)^{\varepsilon - 1} + A(\Sigma, \varphi)^{\varepsilon - 1} \right)^{1 \over \varepsilon - 1} X \]

Hence:

\[ Q(\Sigma, \varphi) = \frac{\eta (q^D, \varphi)}{p_D} s_D^{\varepsilon - 1 \over \varepsilon - 1} \]
IMPORT QUALITY FUNCTION

PROPOSITION

Let $n$ the mass of varieties imported. Then, import price index is given by

$$A(n, \varphi)^{-1} = A(n)^{-1} = zn^\eta$$

where

$$z = \left[ E[q] \left( \frac{\theta - 1}{\theta} \right) \left( \frac{\theta}{\theta - (1 - \nu)(\rho - 1)} \right)^{\frac{1}{(1 - \nu)(\rho - 1)}} \right]^{1 - \nu}$$

$$\eta = \frac{1}{\rho - 1} - \frac{1 - \nu}{\theta}$$
Import Quality Function

Proposition

Let \( n \) be the mass of varieties imported. Then, import price index is given by

\[
A(n, \varphi)^{-1} = A(n)^{-1} = zn^\eta
\]

where

\[
\begin{align*}
  z &= \left[ E[q] \left( \frac{\theta - 1}{\theta} \right) \left( \frac{\theta}{\theta - (1 - \nu)(\rho - 1)} \right)^\frac{1}{(1 - \nu)(\rho - 1)} \right]^{1 - \nu} \\
  \eta &= \frac{1}{\rho - 1} - \frac{1 - \nu}{\theta}
\end{align*}
\]

- Production function for import quality
  - “TFP” \( z \) depends on diversity \((\theta)\), mean quality \((E[q])\), complementarity \((\rho)\)
  - “returns to scale” \( \eta \) depends on diversity \((\theta)\), complementarity \((\rho)\)
**Import Quality Function**

**Proposition**

Let $n$ the mass of varieties imported. Then, import price index is given by

$$A(n, \varphi)^{-1} = A(n)^{-1} = zn^\eta$$

where

$$z = \left[ E[q] \left( \frac{\theta - 1}{\theta} \right) \left( \frac{\theta}{\theta - (1 - \nu)(\rho - 1)} \right)^{\frac{1}{(1 - \nu)(\rho - 1)}} \right]^{1 - \nu}$$

$$\eta = \frac{1}{\rho - 1} - \frac{1 - \nu}{\theta}$$

- Production function for import quality
  - “TFP” $z$ depends on diversity ($\theta$), mean quality ($E[q]$), complementarity ($\rho$)
  - “returns to scale” $\eta$ depends on diversity ($\theta$), complementarity ($\rho$)
- Only need ($z, \eta$) for firms’ problem and hence the macro-exercise
THE GAINS FROM DIVERSITY

RESULT

Consider import quality \( A(n) = zn^\eta \).

1. Diversity increases import productivity \( z \), as

   \[
   z(E[q], \theta, \rho) > E[q]^{1-\nu} = \lim_{\theta \to \infty} z(E[q], \theta, \rho)
   \]

   \[
   \frac{\partial z(E[q], \theta, \rho)}{\partial \theta} < 0
   \]

2. Substitutability increases import productivity \( z \), as \( \frac{\partial z(E[q], \theta, \rho)}{\partial \rho} > 0 \)

3. Diversity and substitutability are complements, as \( \frac{\partial^2 z(E[q], \theta, \rho)}{\partial \theta \partial \rho} < 0 \)

   ▶ Intuition: import productivity \( A \) satisfies

   \[
   A^{\rho-1} = \int_{-q}^{\infty} q^{(1-\nu)(\rho-1)} dG(q).
   \]

   As \( (\rho - 1)(1 - \nu) > 1 \), firms are risk loving and value diversity

   ▶ If \( \rho \) is high, firms can leverage quality differences

   ▶ Similar to input-output linkages in Jones (2011)
PRICES AND MARGINAL COSTS

- Competitive domestic input & final good sectors:

\[ p_D = \tilde{\phi} \frac{1}{M} w^\phi P^{1-\phi} \]

\[ P = \left( \int p_i^{1-\sigma} di \right)^{\frac{1}{1-\sigma}} \]

- Monopolistic competition between producer and FG firm:

\[ p_i = \frac{\sigma}{\sigma - 1} MC_i \]

where

\[ MC_i = \frac{1}{\phi_i} s_D(\Sigma, \varphi) \frac{\gamma}{\varepsilon - 1} \left( \frac{p_D}{\eta_D} \right)^\gamma w^{1-\gamma} h \]
An equilibrium is a set of prices \((w, [p(i)]_i, p_D)\), labor allocations \(([l(i)]_i, [l_F(i)]_i, l_D)\), differentiated product supplies \(([y(i)]_i)\), input demands \(([z_D(i)]_i, [z_c(i)]_{ci})\), quantities of the final good \((Y_C, Y_X, Y_{ROW})\), supply of domestic intermediates \(X_D\) and sourcing strategies \(([\Sigma(i)]_i)\) such that

- Variety producers maximize profits
- Final good producers maximize profits
- Domestic input producers maximize profits
- Trade is balanced
- Markets clear
Estimating the “trade elasticity” $\varepsilon$ (CTD)

Step 1. Estimate production function in each two-digit industry following DeLoecker and Warzynski (2012)

Obtain industry-specific $\hat{\gamma}$ and $\ln(\hat{\vartheta})$ for every firm.

Step 2. Estimate:

$$\Delta \ln(\vartheta_{it}) = \beta_0 + \beta_1 \Delta \gamma_s \ln(s_{D, it}) + u_{it}$$

Instrumenting $\Delta s_{D, it}$ with:

$$z_{it} = \sum_{ck} \Delta WES_{ckt} \times s_{cki}^{pre}$$

where $\Delta WES_{ckt}$ is the change in total exports for product $k$ of country $c$ at year $t$ to the world (excl. France) and $s_{cki}^{pre}$ are firm $i'$s import share on $(k,c)$ prior to our sample.
PF Estimation: Equation

- Observe revenue, not physical output

- Hence estimate:

\[
ln(S) = \delta + \tilde{\alpha}ln(k) + \tilde{\beta}ln(l) + \tilde{\gamma}ln(x) + ln(\omega)
\]

where \( \tilde{\gamma} = \frac{\sigma - 1}{\sigma} \gamma, \tilde{\alpha} = \frac{\sigma - 1}{\sigma} \alpha \) and \( \tilde{\beta} = \frac{\sigma - 1}{\sigma} (1 - \alpha - \gamma) \)

- And:

\[
l(\omega) = \frac{\sigma - 1}{\sigma} ln(\vartheta) = \frac{1}{1 - \varepsilon} \tilde{\gamma}ln(s_D) + \frac{\sigma - 1}{\sigma} ln(\varphi)
\]
### First Stage in Estimation of $\varepsilon$

<table>
<thead>
<tr>
<th></th>
<th>Levels $\gamma_s \times \ln(s_D)$</th>
<th>Differences $\gamma_s \times \Delta \ln(s_D)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>WES</td>
<td>-0.014*** (0.000)</td>
<td></td>
</tr>
<tr>
<td>$\Delta$WES</td>
<td></td>
<td>-0.010*** (0.003)</td>
</tr>
<tr>
<td>$N$</td>
<td>103,333</td>
<td>67,696</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.11</td>
<td>0.00</td>
</tr>
</tbody>
</table>
DISTRIBUTION OF PRODUCTIVITY GAINS IN FRANCE

**Figure:** The distribution of productivity gains \((s_{D,i})^{\frac{\gamma}{1-\epsilon}}\)

- Average gains: 12%, Median gains 5%
# Distributions of Gains: Moments

<table>
<thead>
<tr>
<th>Mean</th>
<th>Median</th>
<th>p25</th>
<th>p75</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1201</td>
<td>1.0517</td>
<td>1.0137</td>
<td>1.1391</td>
<td>114,723</td>
</tr>
</tbody>
</table>

Notes: The Table reports moments of the empirical distribution of $s_{\gamma}^{\epsilon, -1}_{D,i}$. 
## Correlates of the Gains

<table>
<thead>
<tr>
<th></th>
<th>Dep. Variable: Gains from Importing ( \frac{\gamma}{1-\varepsilon} \ln(s_D) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \ln(va) )</td>
<td>0.005***  -0.003***  -0.017***</td>
</tr>
<tr>
<td></td>
<td>(0.000)  (0.000)  (0.000)</td>
</tr>
<tr>
<td>( \ln(l) )</td>
<td>0.002***  0.023***  0.013***</td>
</tr>
<tr>
<td></td>
<td>(0.000)  (0.001)  (0.001)</td>
</tr>
<tr>
<td>Exporter</td>
<td>0.023***  0.013***</td>
</tr>
<tr>
<td></td>
<td>(0.001)  (0.001)</td>
</tr>
<tr>
<td>Foreign Group</td>
<td>0.079***  0.063***</td>
</tr>
<tr>
<td></td>
<td>(0.002)  (0.002)</td>
</tr>
<tr>
<td>Num of varieties</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.083***  0.092***</td>
</tr>
<tr>
<td></td>
<td>(0.001)  (0.001)</td>
</tr>
</tbody>
</table>

**Table:** Variation in the gains from trade
Estimating the “Returns to Variety” $\eta$

- Theory implies that

$$s_D = \frac{(q_D/p_D)^{\varepsilon - 1}}{(q_D/p_D)^{\varepsilon - 1} + (zn\eta)^{\varepsilon - 1}}$$

- Estimate $\eta$ from

$$\frac{1}{\varepsilon - 1} \ln \left( \frac{1 - s_D}{s_D} \right) = \text{const} + \eta \ln(n)$$
THE $\ln(s_D) - \ln(n)$ SCHEDULE

**Figure**: $\log\left(\frac{1-s_D}{s_D}\right) = m(\ln(n))$ in the data
**Estimating Returns to Variety \( \eta (ctd) \)**

\[
\frac{1}{\epsilon - 1} \ln \left( \frac{1 - s_{D,ist}}{s_{D,ist}} \right) = \delta_s + \delta_t + \delta_{nk} + \eta \ln(n_{ist}) + u_{ist}
\]

<table>
<thead>
<tr>
<th></th>
<th>Mutiple Varieties</th>
<th>Full Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Num of varieties</td>
<td>0.253***</td>
<td>0.389***</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Exporter</td>
<td>-0.111***</td>
<td>-0.205***</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.008)</td>
</tr>
<tr>
<td>Foreign Group</td>
<td>0.126***</td>
<td>0.097***</td>
</tr>
<tr>
<td></td>
<td>(0.011)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>( \ln(k/l) )</td>
<td></td>
<td>-0.040***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.003)</td>
</tr>
<tr>
<td>( N )</td>
<td>34,621</td>
<td>114,723</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.23</td>
<td>0.36</td>
</tr>
</tbody>
</table>
**Extensive Margin and $\eta$**

- Extensive margin

\[ n^*(\varphi, f) = \max_n \left\{ D \left( \frac{1}{MC(n)} \right)^{\sigma^{-1}} - nfw - \mathbb{I}(n > 0) f^I w \right\} \]

where

\[ MC \propto \frac{1}{\varphi} \left( \left( \frac{q_D}{p_D} \right)^{\varepsilon^{-1}} + (zn\eta)^{\varepsilon^{-1}} \right)^{-\gamma / \varepsilon^{-1}} \]

- Then

\[ n^*(\varphi, f) \longleftrightarrow s_D(\varphi, f) \]

- Important parameter: $\eta$
# Calibration: Parameters

<table>
<thead>
<tr>
<th>Set Exogenously</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand Elasticity</td>
<td>( \sigma )</td>
<td>3</td>
</tr>
<tr>
<td>Strength of Linkages</td>
<td>( \phi )</td>
<td>((0, 1))</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Estimated</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elasticity of Substitution</td>
<td>( \varepsilon )</td>
<td>2.83</td>
</tr>
<tr>
<td>Returns to Scale of Importing</td>
<td>( \eta )</td>
<td>0.3</td>
</tr>
<tr>
<td>Material Share</td>
<td>( \gamma )</td>
<td>0.63</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calibrated</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dispersion in Productivity</td>
<td>( \sigma^2_\phi )</td>
</tr>
<tr>
<td>Average Fixed Cost</td>
<td>( \mu_f )</td>
</tr>
<tr>
<td>Dispersion in Fixed Costs</td>
<td>( \sigma^2_f )</td>
</tr>
<tr>
<td>Correlation Fixed Costs - Productivity</td>
<td>( \rho )</td>
</tr>
<tr>
<td>Fixed Cost of Being Importer</td>
<td>( f^I )</td>
</tr>
</tbody>
</table>
### Calibration: Gains from Trade

<table>
<thead>
<tr>
<th></th>
<th>( \phi = 0 )</th>
<th>( \phi = 0.25 )</th>
<th>( \phi = 0.5 )</th>
<th>( \phi = 0.75 )</th>
<th>( \phi = 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real Wage Gains (in %)</td>
<td>47.48</td>
<td>31.32</td>
<td>23.35</td>
<td>18.60</td>
<td>15.56</td>
</tr>
<tr>
<td>Welfare Gains (in %)</td>
<td>47.23</td>
<td>36.16</td>
<td>28.21</td>
<td>21.75</td>
<td>16.65</td>
</tr>
<tr>
<td>% of Labor in Fixed Cost Production</td>
<td>0.17</td>
<td>0.91</td>
<td>2.43</td>
<td>4.31</td>
<td>6.10</td>
</tr>
<tr>
<td>VA-weighted Avg Gains (in %)</td>
<td>25.01</td>
<td>25.01</td>
<td>25.01</td>
<td>25.01</td>
<td>25.01</td>
</tr>
</tbody>
</table>
## Calibration: Non-Targeted Moments

<table>
<thead>
<tr>
<th>Non-Targeted Moments</th>
<th>French Data</th>
<th>Baseline</th>
<th>No Micro Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agg Domestic Share (Importers)</td>
<td>0.62</td>
<td>0.63</td>
<td>0.68</td>
</tr>
<tr>
<td>Avg Domestic Share (Importers)</td>
<td>0.70</td>
<td>0.78</td>
<td>0.95</td>
</tr>
<tr>
<td>Dispersion log Sales (Population)</td>
<td>1.59</td>
<td>2.08</td>
<td>3.46</td>
</tr>
<tr>
<td>Share of Sales by Importers</td>
<td>0.79</td>
<td>0.79</td>
<td>0.99</td>
</tr>
</tbody>
</table>
**Variance of Sales**

In terms of obversables:

\[
\text{cov}(\ln(Sales), \ln(s_D)) = (\sigma - 1) \text{cov}(\ln(\phi), \ln(s_D)) - \frac{\gamma (\sigma - 1)}{\varepsilon - 1} \sigma_{s_D}^2
\]

So that

\[
\sigma^2_\phi = \text{var}(\ln(Sales)) + \left( \frac{\gamma}{\varepsilon - 1} \right)^2 \sigma_{s_D}^2
\]

\[
+ \frac{2\gamma}{\varepsilon - 1} \frac{1}{\sigma - 1} \text{corr}(\ln(Sales), \ln(s_D)) \sigma_{Sales} \sigma_{s_D}
\]
Marginal Distributions: Zoom In

- French data
- Baseline
- No domestic share data

Note: the distributions of ln(sales) have been normalized to have a mean of 1.
Correlation Structure