The Gains from Input Trade in Firm-Based Models of 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' production costs
  - This lowers price of domestically produced goods
- Question: by how much?

Challenges

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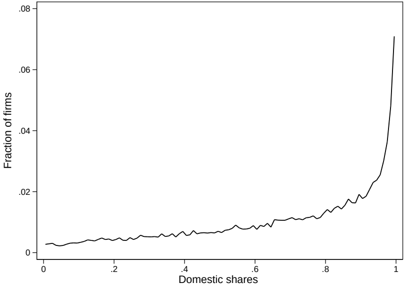

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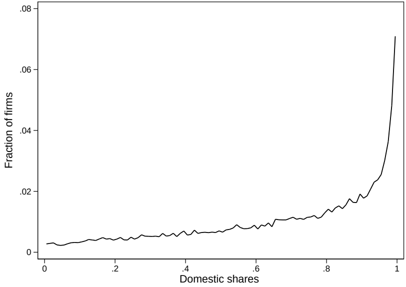

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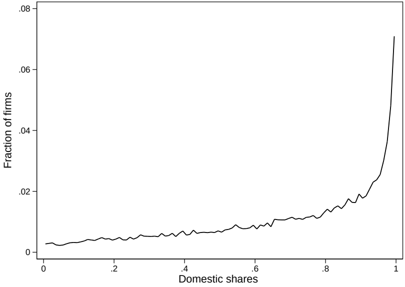

- Accounting for this heterogeneity: resort to firm-based models
- We show that doing so matters

OUR APPROACH (I): MICRO SUFFICIENCY

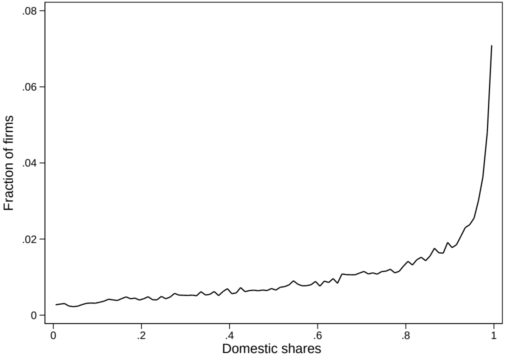

FIGURE : Heterogeneity in Import Intensity

- Domestic expenditure share = unit costs relative to autarky

Our Approach (II): Macro Sufficiency

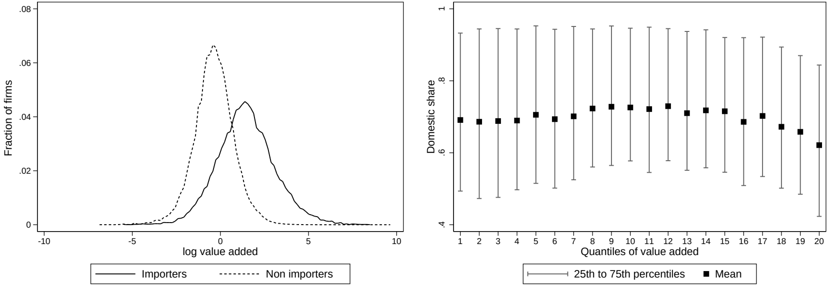

Figure : Import Intensity and Firm Size in France

- Data on value added and domestic shares is sufficient for change in consumer prices relative to autarky
  - Holds in class of models where demand is CES
  - Arbitrary extensive margin of trade

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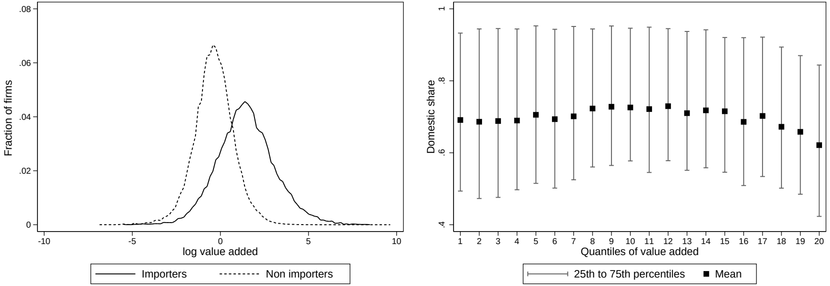

FIGURE : Import Intensity and Firm Size in France

- Data on value added and domestic shares is sufficient for change in consumer prices relative to autarky
  - Holds in class of models where demand is CES
  - Arbitrary extensive margin of trade
- For other counterfactuals, data contains important information

Related Literature

- Aggregate models with input trade:
  - Eaton, Kortum, Kramarz (2011), Caliendo and Parro (2014), Costinot, Rodriguez-Clare (2014)
- Firm-based models of importing:
  - Halpern, Koren, Szeidl (2012), Gopinath and Neiman (2013), Ramanarayanan (2015)
  - Antras, Fort and Tintelnot (2014)
- Sufficient statistics to evaluate trade policy:
  - Arkolakis, Costinot, Rodriguez-Clare (2012)
- Reduced-form analysis of trade reforms:
  - Amiti and Konings (2007), Goldberg, Khandelwal, Pavcnik, Topalova (2010), Kasahara and Rodrigue (2008)

A Model of Importing

Production structure:

$$y = \varphi_i l^{1-\gamma} x^{\gamma} \quad (1)$$

$$x = \left(\beta_i \left(q_D z_D\right)^{\frac{\varepsilon-1}{\varepsilon}} + (1-\beta_i)\, x_I^{\frac{\varepsilon-1}{\varepsilon}} \right)^{\frac{\varepsilon}{\varepsilon-1}} \quad (2)$$

$$x_I = h_i\left(\left[q_{ci} z_c\right]_{c \in \Sigma_i} \right) \quad (3)$$

where

- φ_i is firm efficiency
- q_{ci} is country quality and z_c is quantity sourced
- h_i any CRS production function
- Σ_i is the firm's **sourcing strategy**

Extensive margin: no restrictions

Market Structure

- Input markets: firm faces prices $p_D, [p_{ci}]$ parametric
- Output markets: no restrictions
- This structure nests existing work:
  - Koren, Halpern, Szeidl (2011),
  - Gopinath Neiman (2014),
  - Antràs, Fort, Tintelnot (2015),
  - Amiti, Itskhoki, Konings (2014)
  - Aggregate trade models

Import Demand

Unit cost is given by

$$u_i = \frac{1}{\varphi_i} w^{1-\gamma} Q_i(\Sigma_i)^{\gamma}$$

where

$$Q_i(\Sigma_i) = \left(\beta_i^{\varepsilon} (p_D/q_D)^{1-\varepsilon} + (1-\beta_i)^{\varepsilon} A_i(\Sigma_i)^{1-\varepsilon}\right)^{\frac{1}{1-\varepsilon}}$$

and $A_i(\Sigma_i)$ is the price index of the foreign bundle

Importing and Unit Cost

- $Q_i(\Sigma_i)$ depends on *unobserved* parameters, e.g. $[q_{ci}], [p_{ci}], h_i, \beta_i$

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$$Q_i(\Sigma_i) \propto \frac{p_D}{q_D} s_{Di}^{\frac{1}{\varepsilon - 1}}$$

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- Hence:

$$u_i = \underbrace{1/\varphi_i}_{\text{Exogenous}} \times \underbrace{(s_{Di})^{\frac{\gamma}{\varepsilon-1}}}_{\text{Input trade}} \times \underbrace{(p_D/q_D)^{\gamma} w^{1-\gamma}}_{\text{GE}}$$

Producer Gains from Input Trade

1. Any model in CES class: effect of a trade shock

$$ln\left(\frac{u_i'}{u_i}\right)\Bigg|_{p_D,w} = \frac{\gamma}{1-\varepsilon} ln\left(\frac{s_{Di}}{s_{Di}'}\right)$$

- Conditional on $s_{Di}/s_{Di}^{'}$, import environment does not matter

PRODUCER GAINS FROM INPUT TRADE

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2. Special case: input autarky

$$G_i \equiv ln\left(\frac{u_i^{aut}}{u_i}\right)\Bigg|_{p_D,w} = \frac{\gamma}{1-\varepsilon} ln\left(s_{Di}\right)$$

   - Effect of input trade is observable, given γ and ε
   - Identifies distributional effects of input trade

connection

From Micro to Macro

- So far: distribution of unit cost changes across firms
- Now: quantify effect of input trade on **consumer prices**
- Need to take a stand on:
  1. Consumer demand and output market structure
  2. Linkages across producers

The Macro Model

- Multi-sector CES monopolistic competition structure
- Consumers:

$$U = \prod_{s=1}^{S} C_s^{\alpha_s} \tag{4}$$

$$C_s = \left(\int_0^{N_s} c_{is}^{\frac{\sigma_s - 1}{\sigma_s}} di \right)^{\frac{\sigma_s}{\sigma_s - 1}} \tag{5}$$

- Firm i in sector s:

$$y_i = \varphi_i l^{1-\gamma_s} x^{\gamma_s}$$

$$x = \left(\beta_i \left(q_{Ds} z_{Ds} \right)^{\frac{\varepsilon_s - 1}{\varepsilon_s}} + (1 - \beta_i) x_I^{\frac{\varepsilon_s - 1}{\varepsilon_s}} \right)^{\frac{\varepsilon_s}{\varepsilon_s - 1}}$$

- Domestic bundle:

$$z_{Ds} = \prod_{j=1}^{S} Y_j^{\zeta_j^s}$$

where Y_j is akin to (5)

Input Trade and Consumer Prices

Proposition

Let P be the consumer price index. For any trade shock,

$$ln\left(P^{'}/P\right) = \alpha'\left(\Gamma\left(I - \Xi \times \Gamma\right)^{-1}\Xi + I\right) \times \Lambda$$

where $\Xi \equiv \zeta_j^s$, $\Gamma = diag\left(\gamma\right)$, *and*

$$\Lambda_s = \frac{1}{1-\sigma_s} ln\left(\int_0^{N_s} \frac{va_i}{\int va_i di}\left(\frac{s_{Di}}{s'_{Di}}\right)^{\frac{\gamma_s}{\varepsilon_s - 1}(\sigma_s - 1)} di\right).$$

- Change in consumer prices fully determined from $\left[va_i, \frac{s_{Di}}{s'_{Di}}\right]_i$

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- Change in consumer prices fully determined from $\left[va_i, \frac{s_{Di}}{s'_{Di}}\right]_i$
- Special case of autarky:

$$\Lambda_s = \frac{1}{1-\sigma_s} ln\left(\int_0^{N_s} \frac{va_i}{\int va_i di} s_{Di}^{\frac{\gamma_s}{\varepsilon_s - 1}(\sigma_s - 1)} di\right).$$

Single Sector Intuition

Models of Importing: Aggregate Models

Aggregate models: $s_{Di} = s_D$

- Gains from Input Trade: Proposition 1 with

$$\Lambda_s^{Agg} = \frac{\gamma_s}{1-\varepsilon_s} ln\left(s_D\right) = \frac{\gamma_s}{1-\varepsilon_s} ln\left(s_{Ds}^{Agg}\right)$$

- Bias

$$Bias_s \equiv \Lambda_s^{Agg} - \Lambda_s = \frac{\gamma_s}{\varepsilon_s - 1} \times ln\left[\left(\int_0^{N_s} \frac{va_i}{\int va_i di}\left(\frac{s_{Di}}{s_D^{Agg}}\right)^{\chi_s} di\right)^{1/\chi_s}\right]$$

where $\chi_s = \frac{\gamma_s(\sigma_s - 1)}{\varepsilon_s - 1}$

- Result

$$Bias_s > 0 \iff \chi_s > 1$$

- Also: ε estimated from firm-level data can differ from aggregate trade elasticity

more Back

Quantifying the Gains

- Gains from Input Trade: Consumer prices relative to autarky

- Application to French micro data
  - Population of manufacturing firms
  - Customs data matched to fiscal data at firm-level

- Need to estimate parameters:
  - Estimate (Ξ, α) from aggregate data
    - Can be read off Input-Output matrix
  - Estimate $(\varepsilon, \gamma, \sigma)$ from micro data
    - σ: from profit margins, $\sigma_s \in [1.8, 6]$
    - (ε, γ): production function approach, $\varepsilon \in (1.73, 2.38)$

Table1 Epsilon

THE PRODUCER GAINS

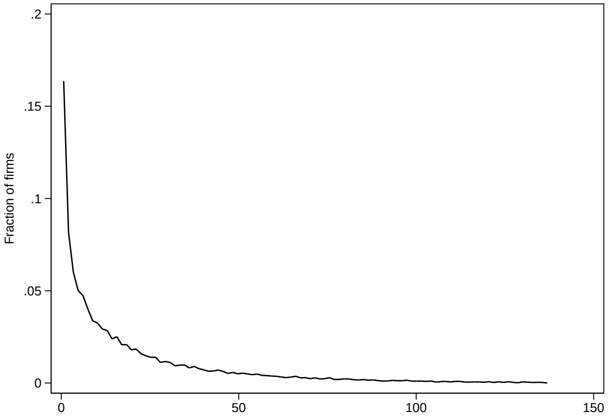

FIGURE : Distribution of Producer Gains from Input Trade,

- Empirical distribution of $(s_{Di}^{\gamma_s/(1-\varepsilon)} - 1) \times 100$
- Vast heterogeneity: 90-10 quantile is $[0.64\%, 86\%]$

Table Correlates

The Consumer Gains

	Manufacturing Sector		Entire Economy	
Consumer Price Gains	27.52	*[21.2,35.9]*	9.04	*[7.1,11.6]*
Aggregate Data	30.86	*[21.5,45.3]*	9.92	*[7.1,14]*
Bias	3.34	*[0.2,10]*	0.88	*[0,2.6]*

TABLE : Consumer Price Gains From Input Trade in France

Bootstrap BySector Bias Formula

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- French consumer prices would be 27.5% higher under input autarky
- When non-manufacturing sector is included, gains amount to 9%
- Relying on aggregate data leads to over-estimating gains
  - But elasticity estimated from aggregate data is also different Bias Eps

Bootstrap BySector Bias Formula

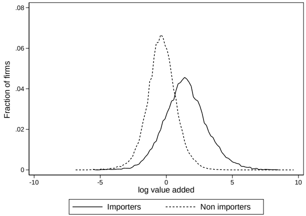
Beyond Autarky and Consumer Prices

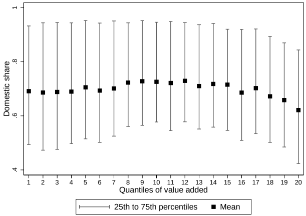
- So far: Change in consumer prices relative to autarky
- Now:
  - Non-autarky counterfactuals: currency devaluation
  - Welfare: take into account resources lost through extensive margin

$$\frac{W}{W^{aut}} = \frac{P^{aut}}{P} \times \left(\frac{L - \int_i^N l_{\Sigma_i} di}{L} \right)$$

- Need a theory of domestic shares:
  - Take a stand on extensive margin: fixed costs fc model
  - Impose functional form assumptions on $[p_c, q_c, f_c]$, form for h_i Structure
  - Balanced trade Closing
- Calibrate the model

Important Information: Firm Size and Import Intensity





- To match this joint distribution: 2 dimensions of heterogeneity
  - efficiency and either (i) fixed costs or (ii) home bias
- We find that:
  - models that match this distribution predict similar changes in consumer prices, regardless of micro structure
  - failing to match this distribution results in substantial biases
  - for welfare: more is required Results

Conclusions

- Input trade is wide-spread but normative implications are hard to characterize
- Spending patterns at the firm level are crucial for our understanding of input trade
  - Capture unit cost changes
  - Agnostic about details of import environment
- If micro data on value added is also available, can measure consumer price gains
  - For reversal to autarky, data is sufficient
  - For other counterfactuals, data is informative
  - Aggregate data gives biased answers

Appendix

RESULTS

Back

		Firm-Based Models				Aggregate Model
		Heterogeneous Fixed Costs	Heterogeneous Home Bias	Homogeneous Fixed Costs	Homogeneous Home Bias	
Panel A: Structural Parameters						
Dispersion in efficiency	σ_{φ}	0.528	0.528	0.513	0.496	0.556
Fixed cost of importing	f_I	0.047	0.058	0.047	0.561	-
Average home bias	$\mu_{\tilde{\beta}}$	$1^{\dagger}$	2.595	$1^{\dagger}$	1.193	1.284
Dispersion in home bias	$\sigma_{\tilde{\beta}}$	-	1.028	-	0	-
Correlation of home bias and efficiency	$\rho_{\tilde{\beta}\varphi}$	-	0.124	-	0	-
Average fixed cost	μ_f	5.059	-	5.475	-	-
Dispersion in fixed cost	σ_f	2.373	-	0	-	-
Correlation of fixed cost and efficiency	$\rho_{f\varphi}$	0.739	-	0	-	-
Panel B: Moments						
	Data					
Aggregate domestic share	0.720	**0.720**	**0.720**	**0.720**	**0.720**	**0.720**
Dispersion in ln va	1.520	**1.520**	**1.520**	**1.520**	**1.520**	**1.520**
Share of importers	0.199	**0.199**	**0.199**	**0.200**	**0.199**	1.000
Dispersion in ln s_D	0.360	**0.360**	**0.360**	0.137	0.179	0.000
Correlation of ln va and ln s_D	-0.310	**-0.310**	**-0.310**	-0.720	-0.768	0.000
Panel C: Reversal to Autarky						
Change in Consumer Prices	$\frac{P^{Aut}-P}{P}$	37.87%	38.01%	43.09%	43.89%	44.73%
	Bias		*0.36%*	*13.78%*	*15.90%*	*18.10%*
Change in Welfare	$\frac{W-W^{Aut}}{W}$	17.43%	36.42%	21.59%	27.81%	44.73%
Panel D: Devaluations						
Change in aggregate import share by ...						
... 5%	$\frac{P'-P}{P}$	1.85%	1.87%	2.08%	2.15%	2.19%
	Bias		*0.79%*	*12.47%*	*16.05%*	*18.21%*
... 10%	$\frac{P'-P}{P}$	3.71%	3.73%	4.17%	4.30%	4.39%
	Bias		*0.67%*	*12.58%*	*16.08%*	*18.31%*
... 20%	$\frac{P'-P}{P}$	7.42%	7.47%	8.37%	8.63%	8.80%
	Bias		*0.67%*	*12.86%*	*16.31%*	*18.55%*

Additional Structure

Back

1. **Extensive margin tractability: $f_c = f$ for all c**
   - **Σ reduces to price-adjusted quality cut-off $\overline{q}$**
2. Country quality is Pareto distributed:

$$G(q) = \Pr(q_c \leq q) = 1 - (q_{min}/q)^{\theta}$$

3. Imported inputs are combined according to:

$$x_I = \left(\int_{c \in \Sigma} (q_c z_c)^{\frac{\kappa-1}{\kappa}} dc \right)^{\frac{\kappa}{\kappa-1}}$$

- Implication: Firm-specific price index

$$A(\Sigma) = \left(\int_{c \in \Sigma} (p_c/q_c)^{1-\kappa} dc \right)^{\frac{1}{1-\kappa}} = zn^{-\eta} \equiv A(n)$$

  - η and z depend on structural parameters $(\kappa, \theta, q_{min})$ Details
  - can directly be estimated from micro-data Estimate η

Firm Problem

Estimating the Elasticity ε

$$y_{is} = \varphi_i l_i^{\phi_{ls}} k_i^{\phi_{ks}} x_i^{\gamma_s} = \tilde{\varphi}_i s_{Di}^{-\frac{\gamma_s}{\varepsilon_s - 1}} l_i^{\phi_{ls}} k_i^{\phi_{ks}} m_i^{\gamma_s}$$

Back

- Input trade akin to firm-specific productivity shifter

EE IV AP

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Back

- Input trade akin to firm-specific productivity shifter
- In terms of revenue:

$$ln(Rev_{is}) = \delta + \tilde{\phi}_{ks} ln(k_i) + \tilde{\phi}_{ls} ln(l_i) + \tilde{\gamma}_s ln(m_i) + ln(\vartheta_i) \quad (6)$$

$$ln(\vartheta_i) = -\frac{1}{\varepsilon_s - 1} \tilde{\gamma}_s ln(s_{Di}) + \frac{\sigma_s - 1}{\sigma_s} ln(\tilde{\varphi}_i) \quad (7)$$

  - Get productivity residuals from (6), then get ε from (7)
  - Or estimate (6)-(7) in one step; PF estimation with additional input

EE IV AP

ESTIMATING THE ELASTICITY ε

$$y_{is} = \varphi_i l_i^{\phi_{ls}} k_i^{\phi_{ks}} x_i^{\gamma_s} = \tilde{\varphi}_i s_{Di}^{-\frac{\gamma_s}{\varepsilon_s - 1}} l_i^{\phi_{ls}} k_i^{\phi_{ks}} m_i^{\gamma_s}$$

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  - Get productivity residuals from (6), then get ε from (7)
  - Or estimate (6)-(7) in one step; PF estimation with additional input
- Endogeneity: Instrument s_D with firm-specific index of shocks to world supply

$$z_{it} = \Delta ln \left(\sum_{ck} WES_{ckt} \times s_{cki}^{pre} \right)$$

EE IV AP

ESTIMATING ε : RESULTS

$$\Delta ln\left(\hat{\vartheta}_{ist}\right) = \delta_s + \delta_t + \frac{1}{1-\varepsilon} \times \Delta\tilde{\gamma}_s ln\left(s^D_{ist}\right) + u_{ist}$$

	First Stage	Factor Shares		2-Step GMM			
				Cobb Douglas		Translog	
		ε	N	ε	N	ε	N
Full sample	-0.019***	2.378***	526,687	1.776***	331,412	1.727***	331,412
	(0.003)	(0.523)		(0.288)		(0.235)	
Importers	-0.010***	2.322**	65,799	1.896**	53,349	1.802**	53,349
	(0.004)	(1.014)		(0.850)		(0.735)	

TABLE : Estimating the Elasticity of Substitution ε

Estimates of $\varepsilon \in (1.73, 2.38)$

Step1FS Step1Proxy GMM GMMeps

SUFFICIENCY RESULT: INTUITION

Back

1. Prices are given by

$$P_s = \frac{\sigma_s}{\sigma_s - 1} \left(\frac{p_{Ds}}{q_{Ds}} \right)^{\gamma_s} \times \left(\int_0^{N_s} \left(\frac{1}{\tilde{\varphi}_i} s_{Di}^{\gamma_s/(\varepsilon_s - 1)} \right)^{1-\sigma_s} di \right)^{\frac{1}{1-\sigma_s}}$$

Sufficiency Result: Intuition

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2. Efficiency $\tilde{\varphi}_i$ is unknown but:

$$va_i = \kappa_s \tilde{\varphi}_i^{\sigma_s - 1} s_D^{\frac{\gamma_s}{1-\varepsilon_s}(\sigma_s - 1)}$$

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3. Hence

$$ln\left(\frac{P_s^{aut}}{P_s}\right) = \gamma_s ln\left(\frac{p_{Ds}^{aut}}{p_{Ds}}\right) + \underbrace{\frac{1}{1-\sigma_s} ln\left(\int_0^{N_s} \frac{va_i}{\int va_i di} s_{Di}^{\frac{\gamma_s}{\varepsilon_s-1}(\sigma_s-1)} di\right)}_{=\Lambda_s}$$

Connection to the literature

back

- Standard approach:
  - Extensive margin: fixed costs
  - Specify import environment $[p_{ci}, q_{ci}, f_{ci}, h_i, \beta_i]$ and output market structure
  - Estimate model
    - Deal with computational complexity fc model
  - Evaluate $Q_i(\Sigma_i)$
- We bypass these difficulties by relying on observable domestic share

Relation to Existing Papers

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

1. Koren, Halpern, Szeidl (2011)
    - 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: $\rho < \infty$

back

A Model with Fixed Costs

back backconnection

$$\pi_i \equiv \max_{\Sigma_i, y} \left\{ \left(p(y) - u_i \right) y - w \sum_{c \in \Sigma_i} f_{ci} \right\},$$

where

$$u_i = \frac{1}{\varphi_i} w^{1-\gamma} \left[\beta_i^{\varepsilon} \left(p_D / q_D \right)^{1-\varepsilon} + (1 - \beta_i)^{\varepsilon} A_i \left(\Sigma_i \right)^{1-\varepsilon} \right]^{\frac{\gamma}{1-\varepsilon}}.$$

- Trade off unit cost reduction vs payment of fixed costs
- Computing optimal Σ_i can be challenging
  - Input complementarities: interdependece of entry decisions
  - When p_{ci}, q_{ci} and f_{ci} vary in arbitrary way: evaluate π_i at every possible Σ_i
- See Antras, Fort and Tintelnot (2014) for solution algorithm

Firm Problem

back

$$\pi = \max_{n} \left\{ u(n)^{1-\sigma} \times B - w\left(nf + f_I \mathbb{I}(n > 0)\right) \right\},$$

where

$$u(n) \equiv \frac{1}{\tilde{\varphi}} w^{1-\gamma} \left(\frac{p_D}{q_D}\right)^{\gamma} s_D(n)^{\frac{\gamma}{\varepsilon-1}}$$

$$s_D(n) = \left(1 + \left(\frac{1-\beta}{\beta}\right)^{\varepsilon} \left(\left(\frac{p_D}{q_D}\right) \frac{1}{z} n^{\eta}\right)^{\varepsilon-1}\right)^{-1}.$$

- This gives a theory of domestic shares:
  - s_D can be large either because n is large or β is low

CONSUMER PRICE GAINS FROM OBSERVED POLICY

- Consider policy that changes domestic shares: $[s_{Di}] \to [s'_{Di}]$
- Effect of policy on consumer prices given by same result but:

$$\Lambda_s^* = \frac{1}{1-\sigma_s} ln \left(\int_{i=0}^{N_s} \frac{va_i}{\int va_i di} \left(s_{Di}/s'_{Di} \right)^{\frac{\gamma_s}{\varepsilon_s - 1}(\sigma_s - 1)} di \right)$$

- Hence, data on value aded and domesic shares before and after is sufficient

back

Consumer Price Gains: Special Cases

- Single sector economy:

$$G = \frac{\Lambda}{1-\gamma}$$

- No cross-industry input-output linkages, i.e. $\zeta_j^s = 0$ for $j \neq s$ and $\zeta_j^j = 1$

$$G = \sum_{s=1}^{S} \alpha_s \frac{\Lambda_s}{1-\gamma_s}$$

back

Bias of Aggregate Data: Intuition

$$P_s = \frac{\sigma_s}{\sigma_s - 1}\left(\frac{p_{Ds}}{q_{Ds}}\right)^{\gamma_s} \times \left(\int_0^{N_s}\left(\frac{1}{\tilde{\varphi}_i} s_{Di}^{\gamma_s/(\varepsilon_s - 1)}\right)^{1-\sigma_s} di\right)^{\frac{1}{1-\sigma_s}}$$

- Consumer price index in trade equilibrium depends on observed value added data
- Quantifying the gains = predicting prices in autarky $\tilde{\varphi}_i^{\sigma-1}$
- Infer from data on value added and domestic shares:

$$\tilde{\varphi}_i^{\sigma_s - 1} \propto va_i s_{Di}^{\frac{\gamma_s}{\varepsilon_s - 1}(\sigma_s - 1)}$$

- If $\frac{\gamma_s}{\varepsilon_s - 1}(\sigma_s - 1) > 1$ then
  - Dispersion in s_{Di} is valued
  - Equalizing domestic shares $\rightarrow$ worse autarky equilibrium, higher gains

back

Demand and Interlinkages Parameters

back

Industry	ISIC	α	σ	γ	VA share	s_D^{Agg}
Mining	10-14	0.02%	2.58	0.33	1.28%	0.90
Food, tobacco, beverages	15-16	9.90%	3.85	0.73	15.24%	0.80
Textiles and leather	17-19	3.20%	3.35	0.63	3.96%	0.54
Wood and wood products	20	0.13%	4.65	0.60	1.67%	0.81
Paper, printing, publishing	21-22	1.37%	2.77	0.50	7.96%	0.75
Chemicals	24	2.04%	3.29	0.67	12.91%	0.60
Rubber and plastics products	25	0.44%	4.05	0.59	5.88%	0.63
Non-metallic mineral products	26	0.24%	3.48	0.53	4.54%	0.72
Basic metals	27	0.01%	5.95	0.67	2.07%	0.60
Metal products (ex machinery and equipment)	28	0.26%	3.27	0.48	9.27%	0.81
Machinery and equipment	29	0.66%	3.52	0.62	7.00%	0.69
Office and computing machinery	30	0.43%	7.39	0.81	0.35%	0.59
Electrical machinery	31	0.47%	4.49	0.60	3.99%	0.64
Radio and communication	32	0.63%	3.46	0.62	1.92%	0.64
Medical and optical instruments	33	0.35%	2.95	0.49	3.83%	0.66
Motor vehicles, trailers	34	4.31%	6.86	0.76	9.99%	0.82
Transport equipment	35	0.37%	1.87	0.35	4.72%	0.64
Manufacturing, recycling	36-37	1.79%	3.94	0.63	3.42%	0.75
Non-manufacturing		73.39%	na	0.41		1

Revenue Production Function

back

- Observe revenue, not physical output
- Rely on demand structure:

$$ln\left(Rev_{is}\right) = \delta + \tilde{\phi}_{ks} ln\left(k_i\right) + \tilde{\phi}_{ls} ln\left(l_i\right) + \tilde{\gamma}_s ln\left(m_i\right) + ln\left(\vartheta_i\right)$$

where the productivity residual ϑ_i is given by

$$ln\left(\vartheta_i\right) = \frac{1}{1-\varepsilon_s}\tilde{\gamma}_s ln\left(s_{Di}\right) + \frac{\sigma_s - 1}{\sigma_s} ln\left(\tilde{\varphi}_i\right)$$

and $\tilde{\gamma}_s = \frac{\sigma_s - 1}{\sigma_s}\gamma_s$ and $\tilde{\phi_{ks}}$ and $\tilde{\phi_{ls}}$ are defined accordingly.

Estimation Approaches

back

- Approach #1: factor shares

$$\tilde{\gamma}_s = \frac{m_i}{p_i y_i}$$

  - measure $\tilde{\gamma}_s$ as average share of material spending across firms
  - measure $\tilde{\phi}_{ks}$ and $\tilde{\phi}_{ls}$ similarly

- Approach #2: estimate (6) with proxy method, akin to Levinson and Petrin (2012)
  - second step as before
  - Cobb-Douglas and Translog

- Approach #3: estimate (6)-(7) in one step
  - treat s_D as an additional input
  - estimate all parameters via GMM following Wooldrige (2009)

Instrument for Domestic Share

back

- Cannot apply OLS as s_D is not orthogonal to φ
  - More efficient firms tend to feature lower domestic shares
- Instrument $\Delta\tilde{\gamma}ln\left(s_D\right)$ with

$$z_{it} = \Delta ln\left(\sum_{ck} WES_{ckt} \times s_{cki}^{pre}\right)$$

  where WES_{ckt} = total exports for product k of county c in year t to the entire world excluding France, s_{cki}^{pre} = import share on product k of county c *prior* to our sample
- z_{it} is a firm-specific index of shocks to the supply of the firm's input bundle.
- Define products at the 6-digit level
- Taking first year as importer to calculate the pre-sample shares s_{cki}^{pre}

First Step, Factor Shares

back

Industry	ISIC	ϕ_k		ϕ_l		γ	
Mining	10-14	0.374***	(0.039)	0.293***	(0.017)	0.333***	(0.043)
Food, tobacco, beverages	15-16	0.098***	(0.004)	0.177***	(0.003)	0.725***	(0.006)
Textiles and leather	17-19	0.081***	(0.003)	0.293***	(0.009)	0.626***	(0.012)
Wood and wood products	20	0.113***	(0.004)	0.285***	(0.006)	0.602***	(0.006)
Paper, printing, publishing	21-22	0.134***	(0.007)	0.362***	(0.011)	0.504***	(0.011)
Chemicals	24	0.124***	(0.008)	0.204***	(0.01)	0.671***	(0.014)
Rubber and plastics products	25	0.124***	(0.005)	0.289***	(0.007)	0.587***	(0.011)
Non-metallic mineral products	26	0.178***	(0.01)	0.294***	(0.012)	0.529***	(0.015)
Basic metals	27	0.124***	(0.01)	0.202***	(0.015)	0.674***	(0.021)
Metal products (ex machinery and equipment)	28	0.108***	(0.002)	0.412***	(0.008)	0.479***	(0.009)
Machinery and equipment	29	0.071***	(0.003)	0.313***	(0.015)	0.616***	(0.018)
Office and computing machinery	30	0.037***	(0.012)	0.150***	(0.032)	0.813***	(0.04)
Electrical machinery	31	0.096***	(0.008)	0.306***	(0.011)	0.598***	(0.014)
Radio and communication	32	0.055***	(0.006)	0.322***	(0.048)	0.624***	(0.052)
Medical and optical instruments	33	0.071***	(0.004)	0.435***	(0.026)	0.494***	(0.029)
Motor vehicles, trailers	34	0.106***	(0.009)	0.135***	(0.016)	0.759***	(0.014)
Transport equipment	35	0.152***	(0.019)	0.499***	(0.03)	0.349***	(0.044)
Manufacturing, recycling	36-37	0.084***	(0.003)	0.283***	(0.009)	0.633***	(0.012)

Table : Production Function Coefficient Estimates, by 2-digit Sector: Factor Shares

First Step, GMM

back

Industry	ISIC	ϕ_k		ϕ_l		γ	
Mining	10-14	0.647***	(0.101)	0.626***	(0.087)	0.295**	(0.139)
Food, tobacco, beverages	15-16	0.174***	(0.010)	0.274***	(0.009)	0.538***	(0.060)
Textiles and leather	17-19	0.216***	(0.026)	0.513***	(0.037)	0.481***	(0.096)
Wood and wood products	20	0.138***	(0.023)	0.414***	(0.024)	0.521***	(0.058)
Paper, printing, publishing	21-22	0.061***	(0.022)	0.717***	(0.033)	0.600***	(0.099)
Chemicals	24	0.027	(0.081)	0.142	(0.134)	1.304***	(0.336)
Rubber and plastics products	25	0.148***	(0.031)	0.536***	(0.050)	0.357***	(0.115)
Non-metallic mineral products	26	0.221***	(0.037)	0.539***	(0.037)	0.357***	(0.119)
Basic metals	27	0.104	(0.096)	0.381***	(0.087)	0.481*	(0.263)
Metal products (ex machinery and equipment)	28	0.252***	(0.013)	0.655***	(0.016)	0.231***	(0.036)
Machinery and equipment	29	0.186***	(0.018)	0.563***	(0.025)	0.393***	(0.066)
Office and computing machinery	30	0.170**	(0.081)	0.574***	(0.110)	0.104	(0.210)
Electrical machinery	31	0.144***	(0.031)	0.448***	(0.044)	0.449***	(0.123)
Radio and communication	32	0.123**	(0.057)	0.565***	(0.114)	0.568***	(0.207)
Medical and optical instruments	33	0.231***	(0.021)	0.501***	(0.020)	0.421***	(0.073)
Motor vehicles, trailers	34	0.082	(0.091)	0.316**	(0.127)	0.765**	(0.355)
Transport equipment	35	0.194***	(0.073)	0.686***	(0.089)	0.997***	(0.256)
Manufacturing, recycling	36-37	0.242***	(0.018)	0.472***	(0.016)	0.430***	(0.055)

Table : Production Function Coefficient Estimates, by 2-digit Sector: 2 Step GMM

ONE-STEP GMM

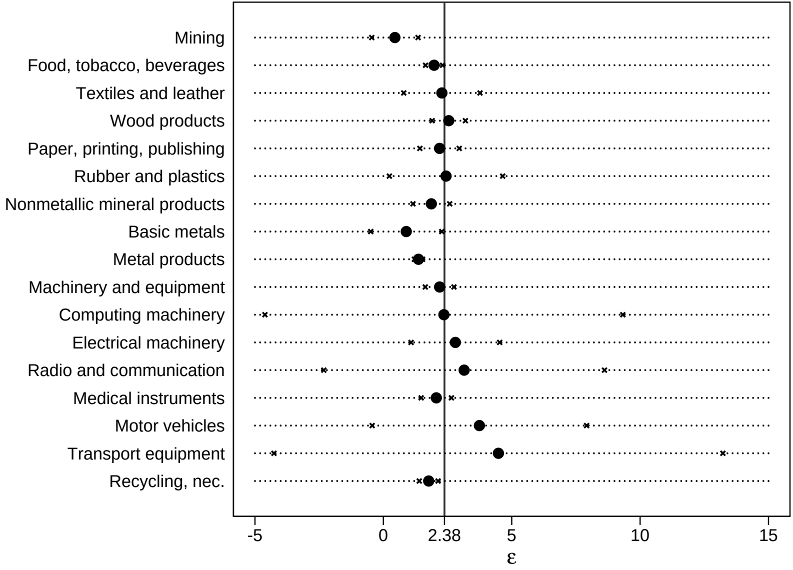
back

Industry	ISIC	ϕ_k		ϕ_l		γ		ε	
Mining	10-14	0.679***	(0.100)	0.617***	(0.088)	0.257*	(0.148)	0.450	(0.451)
Food, tobacco, beverages	15-16	0.173***	(0.010)	0.278***	(0.009)	0.512***	(0.063)	1.976***	(0.166)
Textiles and leather	17-19	0.247***	(0.029)	0.555***	(0.035)	0.354***	(0.101)	2.279***	(0.743)
Wood and wood products	20	0.172***	(0.025)	0.437***	(0.025)	0.441***	(0.061)	2.548***	(0.324)
Paper, printing, publishing	21-22	0.089***	(0.022)	0.726***	(0.032)	0.465***	(0.099)	2.189***	(0.383)
Chemicals	24	0.072	(0.056)	0.250***	(0.084)	1.064***	(0.229)	-6.586	(6.818)
Rubber and plastics products	25	0.163***	(0.032)	0.584***	(0.055)	0.253**	(0.128)	2.442**	(1.103)
Non-metallic mineral products	26	0.221***	(0.036)	0.526***	(0.036)	0.354***	(0.121)	1.869***	(0.358)
Basic metals	27	0.151	(0.120)	0.540***	(0.177)	-0.084	(0.583)	0.892	(0.692)
Metal products (ex machinery and equipment)	28	0.254***	(0.014)	0.667***	(0.016)	0.191***	(0.036)	1.368***	(0.0796)
Machinery and equipment	29	0.183***	(0.018)	0.553***	(0.024)	0.381***	(0.065)	2.191***	(0.279)
Office and computing machinery	30	0.132	(0.087)	0.451***	(0.110)	0.126	(0.222)	2.358	(3.485)
Electrical machinery	31	0.138***	(0.028)	0.460***	(0.037)	0.428***	(0.110)	2.806***	(0.863)
Radio and communication	32	0.132*	(0.069)	0.614***	(0.144)	0.442*	(0.264)	3.147	(2.733)
Medical and optical instruments	33	0.237***	(0.021)	0.498***	(0.020)	0.372***	(0.073)	2.062***	(0.295)
Motor vehicles, trailers	34	0.089	(0.087)	0.354***	(0.120)	0.706**	(0.344)	3.741*	(2.088)
Transport equipment	35	0.170**	(0.081)	0.664***	(0.094)	0.955***	(0.282)	4.482	(4.371)
Manufacturing, recycling	36-37	0.263***	(0.019)	0.468***	(0.017)	0.361***	(0.059)	1.765***	(0.183)

TABLE : Production Function Coefficient Estimates, by 2-digit Sector: 1 Step GMM

One-Step GMM: Results

back



Producer Gains: Summary

Mean	Quantile				
	10	25	50	70	90
24.87	0.64	2.79	11.18	33.74	85.73

TABLE : Moments of the Distribution of Producer Gains in France

- Table reports empirical distribution of $\left(s_{Di}^{\gamma_s/(1-\varepsilon)} - 1\right) \times 100$
- The data for the domestic expenditure share corresponds to the cross-section of importing firms in 2004.

Back

PRODUCER GAINS: CORRELATES

	Dependent variable: Producer gains $\frac{\gamma}{1-\varepsilon} ln\left(s_{Di}\right)$							
ln(Value Added)	0.028***		0.013***	0.005***		-0.008***		-0.029***
	(0.000)		(0.000)	(0.001)		(0.001)		(0.001)
ln(Employment)		0.028***			-0.000			
		(0.000)			(0.001)			
Exporter			0.085***			0.040***		0.024***
			(0.001)			(0.002)		(0.002)
Intl. Group			0.148***			0.138***		0.113***
			(0.003)			(0.003)		(0.003)
ln (Num. Varieties)							0.128***	0.144***
							(0.002)	(0.002)
Sample	Full sample			Importers Only				
Observations	633,240	640,610	633,240	118,799	120,344	118,799	120,344	118,799

TABLE : Cross-Sectional Variation in Producer Gains

Regressions include sector and time FE

Back

CONSUMER GAINS: BOOTSTRAP DISTRIBUTION

Back

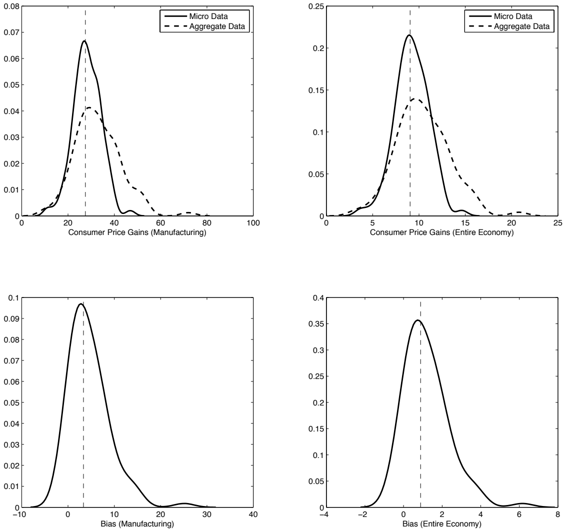


FIGURE : Bootstrap Distribution of Consumer Price Gains and Bias

Consumer Gains: By Type and Sector

Back

Industry	ISIC	Direct Price Reductions		Domestic Inputs		Sectoral Price Gains		Aggregate Data	
Mining	10-14	3.0	*[1.8,4.2]*	14.9	*[11.1,19.2]*	7.8	*[5.2,10.3]*	2.5	*[1.6,3.6]*
Food, tobacco, beverages	15-16	11.1	*[7.5,14.6]*	8.4	*[6.2,10.6]*	17.8	*[12.4,23.4]*	12.6	*[7.8,18.2]*
Textiles and leather	17-19	31.1	*[24.2,39.9]*	31.4	*[24.3,40.3]*	55.6	*[42.4,74]*	31.9	*[22.4,46.9]*
Wood and wood products	20	8.2	*[6.4,10.5]*	9.6	*[7.4,12.1]*	14.4	*[11.1,18.2]*	9.6	*[6.7,13.7]*
Paper, printing, publishing	21-22	12.2	*[9,16]*	14.5	*[10.9,18.7]*	20.1	*[14.7,26.5]*	11.0	*[7.7,15.4]*
Chemicals	24	27.2	*[20.1,36.4]*	21.6	*[16.1,28.2]*	45.1	*[32.7,60.7]*	28.1	*[18.7,41.8]*
Rubber and plastics products	25	20.1	*[14.3,26.5]*	27.3	*[20.2,36]*	38.4	*[27.5,50.9]*	21.5	*[13.9,31]*
Non-metallic mineral products	26	13.4	*[9.6,17.9]*	12.7	*[9.7,16.3]*	20.8	*[15.3,27.4]*	13.3	*[9,19]*
Basic metals	27	21.8	*[16.3,27.7]*	21.5	*[16.4,27.3]*	38.9	*[28.2,50.2]*	28.8	*[19,41.6]*
Metal products (ex machinery and equipment)	28	8.2	*[6.2,10.5]*	20.5	*[15.5,26.2]*	18.3	*[13.8,23.5]*	7.7	*[5.5,10.8]*
Machinery and equipment	29	17.6	*[12.8,23.2]*	20.0	*[15,25.7]*	31.7	*[23,41.6]*	18.2	*[12.2,26.2]*
Office and computing machinery	30	20.4	*[15.4,25.5]*	25.2	*[18.3,32.1]*	44.6	*[31.9,57]*	37.0	*[22.4,60.3]*
Electrical machinery	31	19.8	*[14.6,25.6]*	23.9	*[17.7,30.6]*	36.1	*[26.4,46.6]*	21.6	*[14.8,30.7]*
Radio and communication	32	21.5	*[13.1,31.1]*	23.3	*[16.6,30.5]*	38.5	*[23.5,54.8]*	22.1	*[12.5,36.1]*
Medical and optical instruments	33	17.9	*[12.8,23.4]*	20.4	*[15.1,26.2]*	29.2	*[21.1,38.3]*	15.9	*[10.7,22.5]*
Motor vehicles, trailers	34	6.2	*[3.2,16.4]*	21.7	*[17,29.3]*	23.3	*[17.4,39]*	11.2	*[6.1,24.3]*
Transport equipment	35	15.3	*[10.5,22]*	19.9	*[14.5,27.2]*	22.9	*[16,33.2]*	11.8	*[7.9,18.2]*
Manufacturing, recycling	36-37	12.9	*[9.7,16.3]*	19.0	*[14.5,24]*	26.0	*[19.2,33.4]*	14.1	*[9.5,20.4]*
Non-manufacturing		0.0	*[0,0]*	7.5	*[5.7,9.4]*	3.0	*[2.3,3.8]*	0.0	*[0,0]*

Elasticity Bias

Back

	Micro-data	Aggregate Data				
				ε		
	2.378	2.378	3	4	5	6
Entire Economy	9.04	9.9	6.72	4.43	3.31	2.64
Manufacturing Sector	27.52	30.8	20.32	13.12	9.69	7.68

Table : The Consumer Price Gains for Different Values of ε

- Aggregate approaches typically find values larger than our benchmark estimate of $\varepsilon = 2.378$, see Simonovska and Waugh (2013, 2014)
- e.g. Costinot and Rodriguez-Clare (2014) use $\varepsilon = 4$
- **This would lead to under-estimating gains by 50%**

Import Quality Function

back

Proposition

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

$$A(\Sigma) = \left(\int_{c \in \Sigma} (p_c / q_c)^{1-\kappa} dc \right)^{\frac{1}{1-\kappa}} = z n^{-\eta} \equiv A(n),$$

where

$$z \equiv q_{min}^{\nu - 1} \left(\frac{\theta}{\theta - (1-\nu)(\kappa - 1)} \right)^{\frac{1}{1-\kappa}} \quad (8)$$

$$\eta \equiv \frac{1}{\kappa - 1} - \frac{1-\nu}{\theta}. \quad (9)$$

- Production function for import quality
  - "TFP" z depends on diversity (θ), mean quality (q_{min}), complementarity (κ)
  - "returns to scale" η depends on diversity (θ), complementarity (κ)
- Only need (z, η) for firms' problem and hence the macro-exercise Details

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

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

  As $(\rho - 1)(1 - \nu) > 1$, firms are *risk loving* and value diversity
- If ρ is high, firms can leverage quality differences
- Similar to input-output linkages in Jones (2011)

back

CLOSING THE MODEL

- Supply of foreign inputs is perfectly elastic at price p_c
- Foreign firms demand output of local firms with same CES demand as domestic consumers and producers
- Balance trade:

$$\int_i p_i z_i^{ROW} = \int_i (1 - s_{D,i}) m_i di,$$

where z_i^{ROW} is foreign demand for firm i's production.

- Labor market clearing:

$$L = \int_i \left(l_i + l_i^F\right) di$$

Back

ESTIMATING THE "RETURNS TO VARIETY" η

back

- Theory implies that

$$s_D(n) = \frac{1}{1 + \left(\frac{p_D}{q_D}\frac{1}{z}n^{\eta}\right)^{\varepsilon - 1}}$$

- Estimate η from

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

results

ESTIMATING RETURNS TO VARIETY $\eta(ctd)$

back

$$ln\left(\frac{1-s_{Dist}}{s_{Dist}}\right) = \delta_s + \delta_t + \delta_{NK} + \eta\,(\varepsilon - 1)\,ln\,(n_{ist}) + u_{ist}$$

Dep. Variable: $ln(\frac{1-s_D}{s_D})$						
	All Importers				> 1 variety	> 2 varieties
ln (Number of Varieties)	1.308***	0.707***	0.733***	0.739***	0.526***	0.463***
	(0.009)	(0.010)	(0.010)	(0.010)	(0.011)	(0.019)
ln (Capital / Employment)				-0.070***		
				(0.006)		
Exporter Dummy			-0.395***	-0.388***	-0.254***	-0.198***
			(0.013)	(0.013)	(0.017)	(0.029)
International Group			0.150***	0.174***	0.216***	0.223***
			(0.016)	(0.016)	(0.016)	(0.019)
Control for Num of products	No	Yes	Yes	Yes	Yes	Yes
Implied Eta	0.950***	0.513***	0.532***	0.536***	0.382***	0.336***
	(0.260)	(0.142)	(0.147)	(0.148)	(0.106)	(0.096)
Observations	120,344	120,344	120,344	120,344	73,651	35,751

THE $ln(s_D) - ln(n)$ SCHEDULE

back

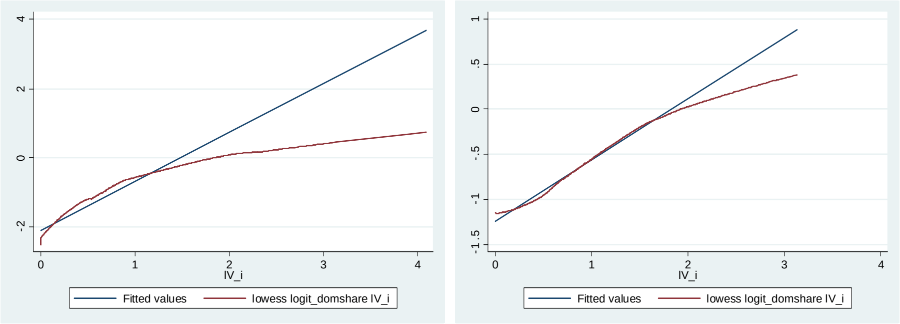


FIGURE : $log\left(\frac{1-s_D}{s_D}\right) = m(ln(n))$ in the data

Extensive Margin and η

back

- Extensive margin foc

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

where

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

- Then

$$n^*(\varphi, f) \longleftrightarrow s_D(\varphi, f)$$

- Important parameter: η

VARIANCE OF SALES

Back

In terms of observable:

$$cov(ln(Sales), ln(s_D)) = (\sigma - 1)\, cov(ln(\varphi), ln(s_D)) - \frac{\gamma(\sigma-1)}{\varepsilon - 1}\sigma_{s_D}^2$$

So that

$$\sigma_\varphi^2 = var(ln(Sales)) + \left(\frac{\gamma}{\varepsilon-1}\right)^2 \sigma_{s_D}^2 + \frac{2\gamma}{\varepsilon-1}\frac{1}{\sigma-1} corr(ln(Sales), ln(s_D))\sigma_{Sales}\sigma_{s_D}$$

Marginal Distributions

Back

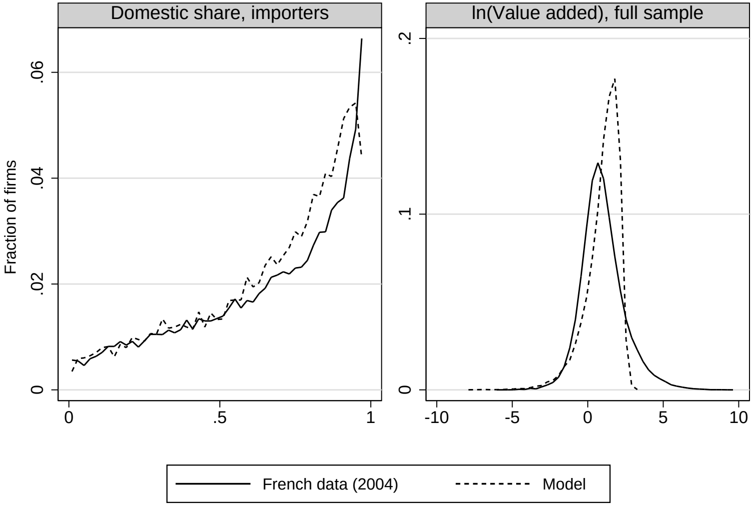


Figure : Marginal Distributions: Model and Data

Calibration: Non-Targeted Moments

Non-Targeted Moments	French Data	Baseline
Avg Domestic Share (Importers)	0.70	0.67
Avg Domestic Share (Population)	0.94	0.93
Agg Domestic Share (Importers)	0.63	0.52
Dispersion log Value Added (Importers)	1.62	1.02
Dispersion log Dom Shares (Importers)	0.69	0.65
Correlation log Value Added - log Dom Shares (Importers)	-0.01	-0.06
Share of Value Added by Importers	0.79	0.59

Table : Non-Targeted Moments

Back

Correlation Structure

Back

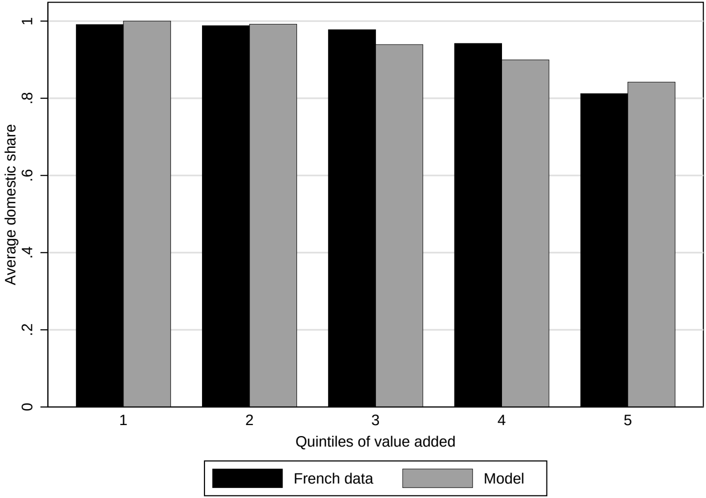


Figure : Correlation Structure: Model and Data

What We Do

- Study **class** of firm-based models of importing:
  - Heterogeneous firms
  - CES between domestic and foreign inputs
  - Many heterogeneous sourcing countries
  - Love of variety + quality channel
  - Arbitrary extensive margin of trade
  - Rich input-output structure across firms

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- Nests most contributions in the literature
- Sufficiency result:
  - Effect of input trade on consumer prices can be read off the microdata on value added and domestic shares