Offshoring and skill-upgrading in French manufacturing: a Heckscher-Ohlin-Melitz view

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Motivation

- How does offshoring affect the skill bias of domestic production?
- Trade theory has traditionally focused on *inter-industry* effects
- However, recent evidence shows :
    1. wide within-industry variation in firm-level skill intensities, even within narrowly defined industries (e.g. Corcos et al 2013).
    2. firm-level skill intensity correlated with firm size, TFP and trade participation.
- Possible explanation: cross-firm differences in factor intensities arise from the interaction of *(i)* firm-level productivity differences and *(ii)* "offshoring costs", causing certain firms to self-select into imports of intermediates

Our paper

- We develop a factor-proportions model with heterogeneous firms that face the possibility of importing intermediate inputs, which differ in their factor intensity, subject to (variable and fixed) offshoring costs.

- Offshoring arises because of relative factor price differences across countries.

- However, only the large (more productive) firms find it profitable to offshore.

- The model delivers predictions relating TFP, imports, and factor intensity which we test using detailed data on French manufacturing firms.

Contribution

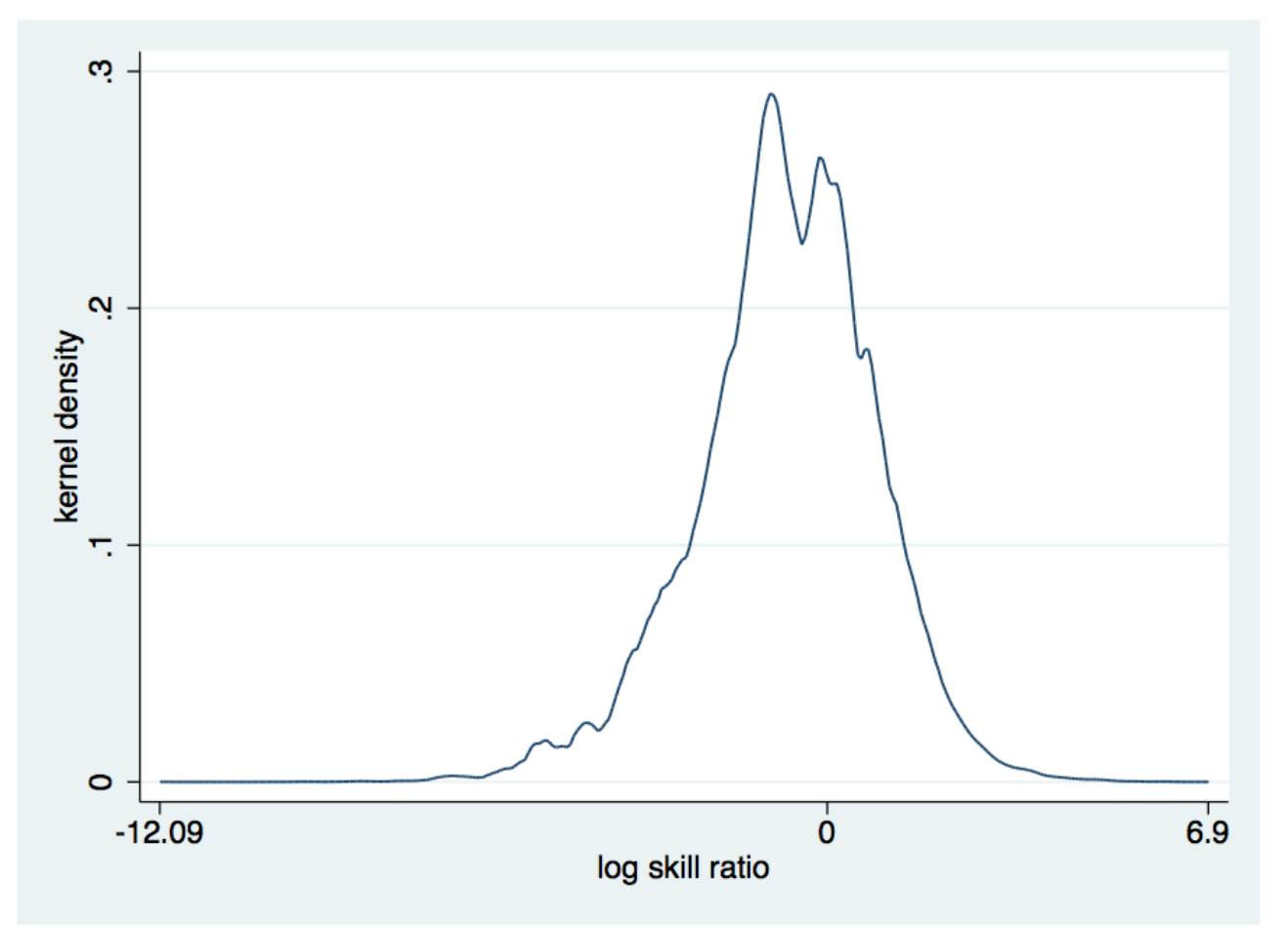
- In order to understand the impact of international trade on factor prices and the factor content of trade, we **not only** need to look at **industry aggregates** (like traditional Heckscher-Ohlin literature), but also **within the industry** and **within the firm**.

- Whereas the **between-industry** variation in factor intensities is a necessary assumption in the standard Heckscher-Ohlin model, the **within-industry** variation arising here is the result of Heckscher-Ohlin forces in combination with firm-heterogeneity in productivity.

- Within-firm skill upgrading can be explained partly by "Heckscher-Ohlin driven offshoring"

A preliminary look at the data

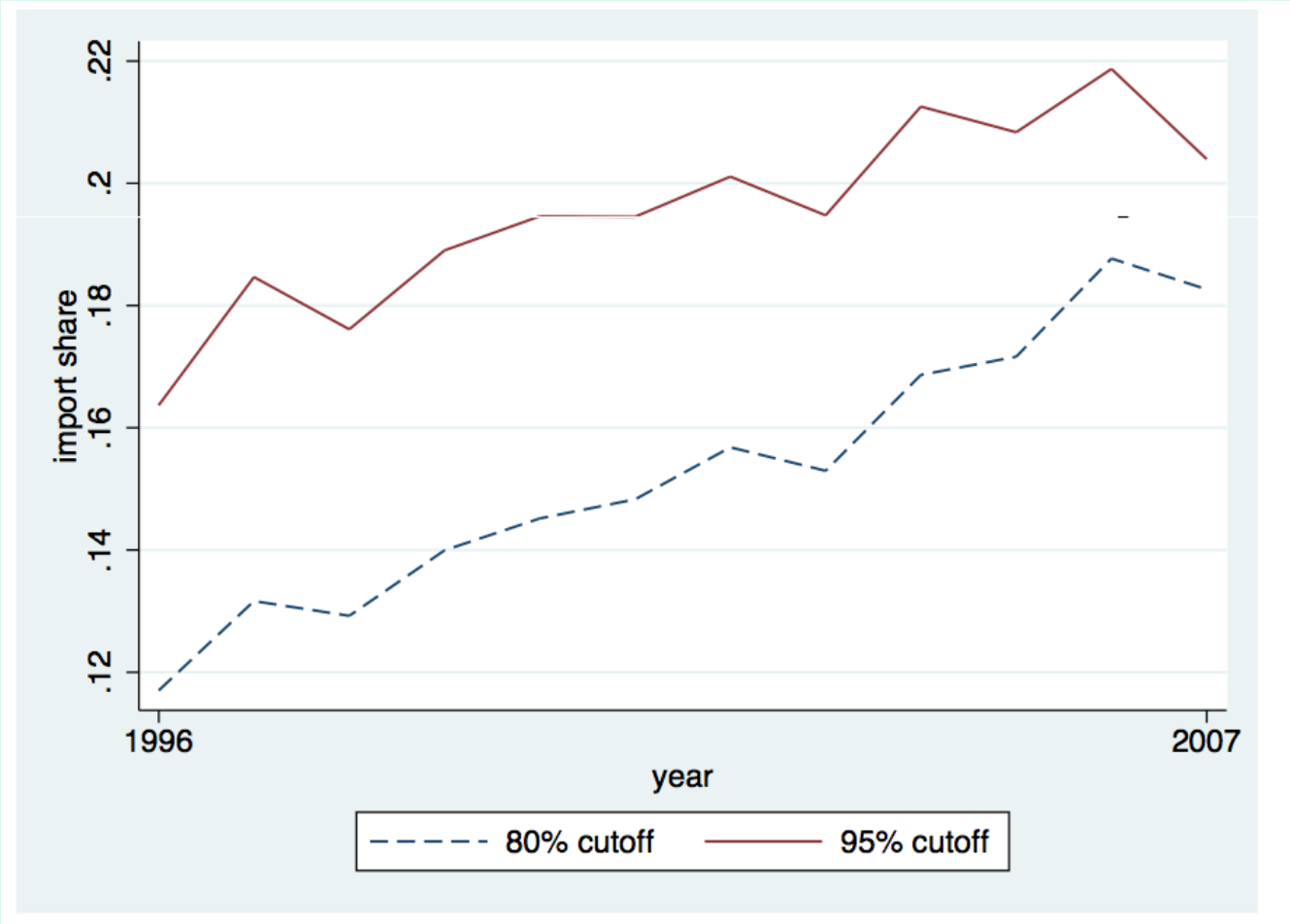
Distribution of firm-level skill intensity
(log) ratio non-production workers/production workers



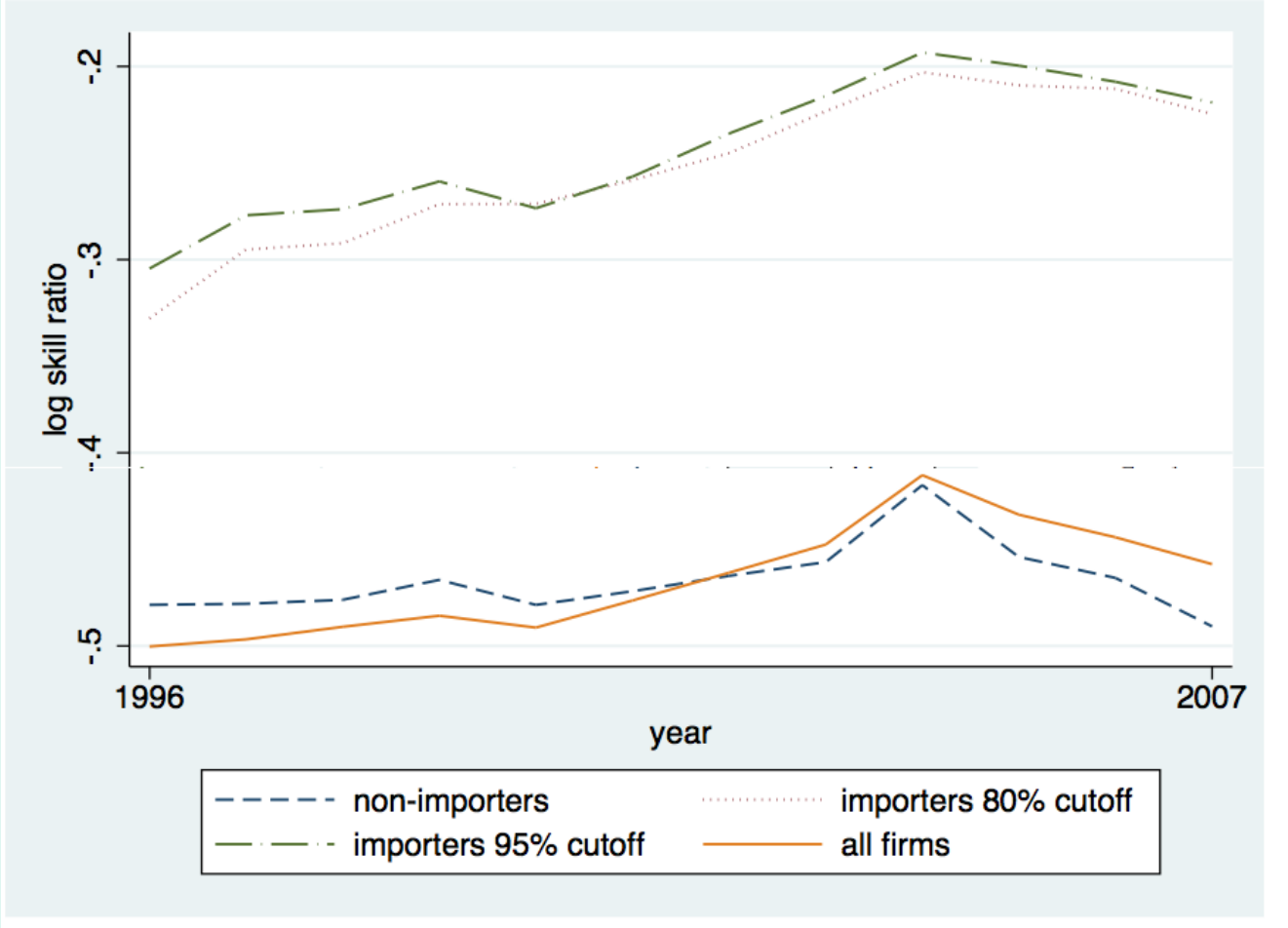
Variation in skill intensity
(log of ratio non-production workers/production workers)

Year	Obs.	Mean	Std. Dev.	Coeff. Variation	Frac. Variance between sectors	Frac. Variance within sectors
1996	55,806	-0.500	0.968	1.935	0.205	0.795
1997	57,452	-0.496	0.970	1.953	0.209	0.790
1998	56,022	-0.490	0.978	1.996	0.204	0.796
1999	56,494	-0.484	0.978	2.018	0.213	0.787
2000	54,425	-0.490	0.985	2.008	0.206	0.793
2001	53,778	-0.476	0.985	2.066	0.210	0.790
2002	55,911	-0.462	0.984	2.128	0.196	0.804
2003	54,428	-0.447	0.984	2.199	0.204	0.796
2004	53,097	-0.412	0.996	2.421	0.195	0.805
2005	52,085	-0.432	0.985	2.281	0.205	0.795
2006	51,670	-0.444	0.989	2.229	0.212	0.788
2007	45,752	-0.458	0.993	2.169	0.223	0.777
All	646,920	-0.467	0.983	2.105	0.200	0.800

Trends in French offshoring: increasing share of imports from labor-abundant countries



Trend in French firm-level skill intensity by import status



Variation in skill intensity: importers *vs.* non-importers

	Non-Importers				Importers (countries $\leq$ 80% French schooling)			
Year	Obs.	Mean	Std. Dev.	Coeff. Variation	Obs.	Mean	Std. Dev.	Coeff. Variation
1996	30,386	-0.479	0.932	1.947	4,907	-0.330	1.051	3.181
1997	30,815	-0.478	0.933	1.951	5,361	-0.295	1.076	3.651
1998	29,296	-0.476	0.939	1.972	5,742	-0.292	1.093	3.750
1999	29,670	-0.466	0.940	2.018	6,121	-0.271	1.072	3.952
2000	28,298	-0.479	0.946	1.977	6,627	-0.271	1.087	4.010
2001	27,810	-0.472	0.944	2.002	6,919	-0.259	1.102	4.258
2002	29,110	-0.464	0.941	2.030	7,462	-0.245	1.094	4.467
2003	28,040	-0.456	0.943	2.067	7,643	-0.223	1.091	4.889
2004	27,328	-0.418	0.965	2.316	8,038	-0.203	1.068	5.261
2005	26,866	-0.454	0.949	2.090	8,479	-0.210	1.061	5.060
2006	26,971	-0.465	0.955	2.054	8,873	-0.212	1.058	5.001
2007	23,658	-0.490	0.957	1.954	8,536	-0.225	1.059	4.715
All	338,248	-0.466	0.945	2.027	84,708	-0.246	1.076	4.370

Literature

- Vertical FDI: Helpman (1984), Antràs (2003)
- FDI with firm heterogeneity: Helpman, Melitz and Yeaple (2004), Antràs and Helpman (2004)
- Offshoring (no firm boundaries, homogeneous firms): Feenstra and Hanson (1997), Grossman and Rossi-Hansberg (2008)
- Heckscher-Ohlin and firm heterogeneity: Bernard, Redding and Schott (2007), Burstein and Vogel (2012), Crozet and Trionfetti (2013)
- Empirical studies of offshoring effects on skill premium/relative demand for skill: Feenstra and Hanson (1999): U.S., Hummels, Jorgensen, Munk, Xiang (2011): Denmark, Biscourp and Kramarz (2007): France

Outline of the talk

- Model
  - Two intermediate inputs, two countries
  - A continuum of intermediate inputs, three countries
- Empirical predictions
- Data
- Empirical results

Model

- Two countries, Home and Foreign, identical in preferences and technologies.

- Two internationally immobile production factors, *H* (skilled labor or "skills") and *L* (unskilled labor or "labor").

  - Home skill abundant: $H/L > H^*/L^*$.

  - Symmetric endowments: $H = L^*$ and $H^* = L$.

- One final-good industry with Dixit-Stiglitz preferences over final-good varieties:

$$Q = \left[\int_{\omega \in \Omega} q(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}}, \quad \sigma > 1$$

Model

- Heterogeneous firms produce each a differentiated variety of the final good, over which they have monopoly power.

- Firms produce final-good varieties by assembling two intermediate inputs:

$$MC(\gamma) = \gamma^{-1} p_1^{1/2} p_2^{1/2}$$

- γ is firm specific, and has the same distribution in both countries. For simplicity, we assume Pareto: $v(\gamma) = a\gamma^{-(a+1)}$, $\gamma \geq 1$, $a > \sigma - 1$.

- Producers of varieties pay a fixed cost f^e for picking a draw γ. (All fixed costs in terms of the final good.) There is free entry.

- "Extreme" intensities for intermediate inputs: $y_1 = h/\tau^j$, $y_2 = l/\tau^j$, $j = o,n$.

- Free trade in final goods.

Model

- Producers of varieties can obtain intermediate inputs in two ways:
  - Produce them in-house, in which case $\tau^n = 1$.
  - Outsource or offshore them at a fixed cost f^o per type of intermediate input and a "variable offshoring cost" τ^o, $1 < \tau^o < H/L$.
- Production of inputs operates in a competitive environment.
- Factor markets are competitive.
- We choose w_h as the numéraire.

Offshoring decision

- No firm finds it worth outsourcing in its own country because of the costs f^o, τ^o and the lack of any cost advantage of doing so.

- If $w_l = w_h^* > w_h = w_l^* = 1$, it is not worth offshoring abroad the intermediate input intensive in the own country‘s abundant factor.

➔ The outsourcing decision is reduced to whether or not to offshore the intermediate input intensive in the own country‘s scarce factor.

- Final-good producers will simply weigh the gain from a lower marginal cost against a fixed cost:

  – For $\gamma \geq \gamma_o$, the firm offshores the entire production of the intermediate input (intensive in the own country‘s scarce factor).

  – For $\gamma < \gamma_o$, the firm produces the two intermediate inputs in-house.

Offshoring decision

- Conditional upon entry, a home firm‘s profits (abstracting from entry costs) are

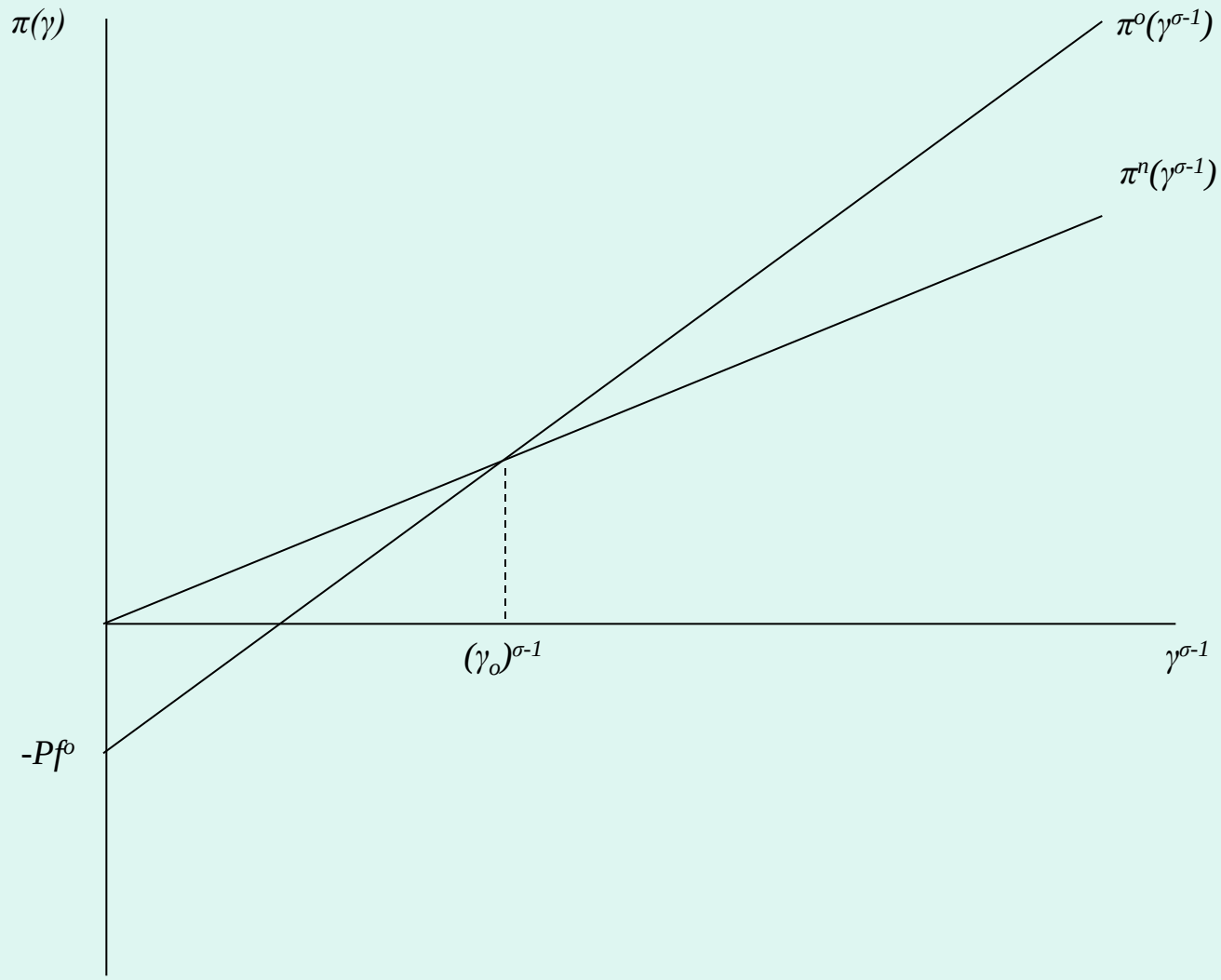
$$\pi^{j}(\gamma)=\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}\frac{2E}{\sigma P^{1-\sigma}}MC^{j}(\gamma)^{1-\sigma}-I(\gamma)Pf^{o}$$

- $j = o$ and $I(\gamma) = 1$ for $\gamma \geq \gamma_o$, and $j = n$ and $I(\gamma) = 0$ for $\gamma < \gamma_o$.

- The profit function resulting from offshoring is steeper than that without offshoring because $MC^o(\gamma) = \gamma^{-1}(\tau^o)^{1/2} < MC^n(\gamma) = \gamma^{-1}(w_l)^{1/2}$.

- [Later on we will prove that in equilibrium $\tau^o < w_l$.]

Offshoring decision



Model

- The symmetry of the model implies

$$\gamma_o = \gamma_o^*, M = M^*, P = P^*, w_l = w_h^*, w_h = w_l^*,$$
$$E \equiv w_h H + w_l L = w_h^* H^* + w_l^* L^* \equiv E^*$$

- It is convenient to assume $\sigma > 2$ (see free-entry condition below).

- We conjecture $\tau^o < w_l = w_h^* < H/L$ and prove this is the case in equilibrium.

Equilibrium conditions

- Free entry:

$$\int_1^{\infty}\left[\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}\frac{2E}{\sigma P^{1-\sigma}}MC^{j}(\gamma)^{1-\sigma}-I^{j}(\gamma)Pf^{o}\right]dG(\gamma)=Pf^{e}$$

- Offshoring decision:

$$\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}\frac{2E}{\sigma P^{1-\sigma}}\left[MC^{o}(\gamma_o)^{1-\sigma}-MC^{n}(\gamma_o)^{1-\sigma}\right]-Pf^{o}=0$$

- Price level:

$$P^{1-\sigma}=\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}2M\left[\int_1^{\gamma_o}\left(\gamma^{-1}w_l^{1/2}\right)^{1-\sigma}dG(\gamma)+\left(\tau^{o}\right)^{\frac{1-\sigma}{2}}\int_{\gamma_o}^{\infty}\gamma^{\sigma-1}dG(\gamma)\right]$$

- Factor-market clearing:

$$\frac{\frac{1}{2}\int_1^{\gamma_o}\left(\gamma^{-1}w_l^{1/2}\right)^{1-\sigma}dG(\gamma)+\left(\tau^{o}\right)^{\frac{1-\sigma}{2}}\int_{\gamma_0}^{\infty}\gamma^{\sigma-1}dG(\gamma)}{\frac{1}{2}\int_1^{\gamma_o}\left(\gamma^{-1}w_l^{1/2}\right)^{1-\sigma}dG(\gamma)}=w_l^{-1}\frac{H}{L}$$

Equilibrium

- Offshoring, free entry, and price level (OFE):

$$\frac{(a-\sigma+1)a^{-1}\gamma_o^{\sigma-1}\left[\left(\tau^o\right)^{\frac{1}{2}(\sigma-1)}-w_l^{\frac{1}{2}(\sigma-1)}\right]\left(\gamma_o^{-a}+f^e/f^o\right)}{w_l^{\frac{1}{2}(1-\sigma)}\left(1-\gamma_o^{\sigma-a-1}\right)+\gamma_o^{\sigma-a-1}}=1$$

- Factor-market clearing (FMC):

$$\gamma_o^{\sigma-a-1}=\frac{\frac{1}{2}w_l^{\frac{1}{2}(1-\sigma)}\left(w_l^{-1}\frac{H}{L}-1\right)}{\frac{1}{2}w_l^{\frac{1}{2}(1-\sigma)}\left(w_l^{-1}\frac{H}{L}-1\right)+\left(\tau^o\right)^{\frac{1-\sigma}{2}}}$$

➔ Can solve for w_l and γ_o from this system. (P and M are functions of these two variables only.)

Equilibrium

- **FMC: positive relationship between γ_o and w_l.** The fewer firms outsource, the stronger the relative demand for labor at home, and therefore the higher the relative factor price w_l.

  - For $w_l = \tau^o$, $\gamma_o > 1$.

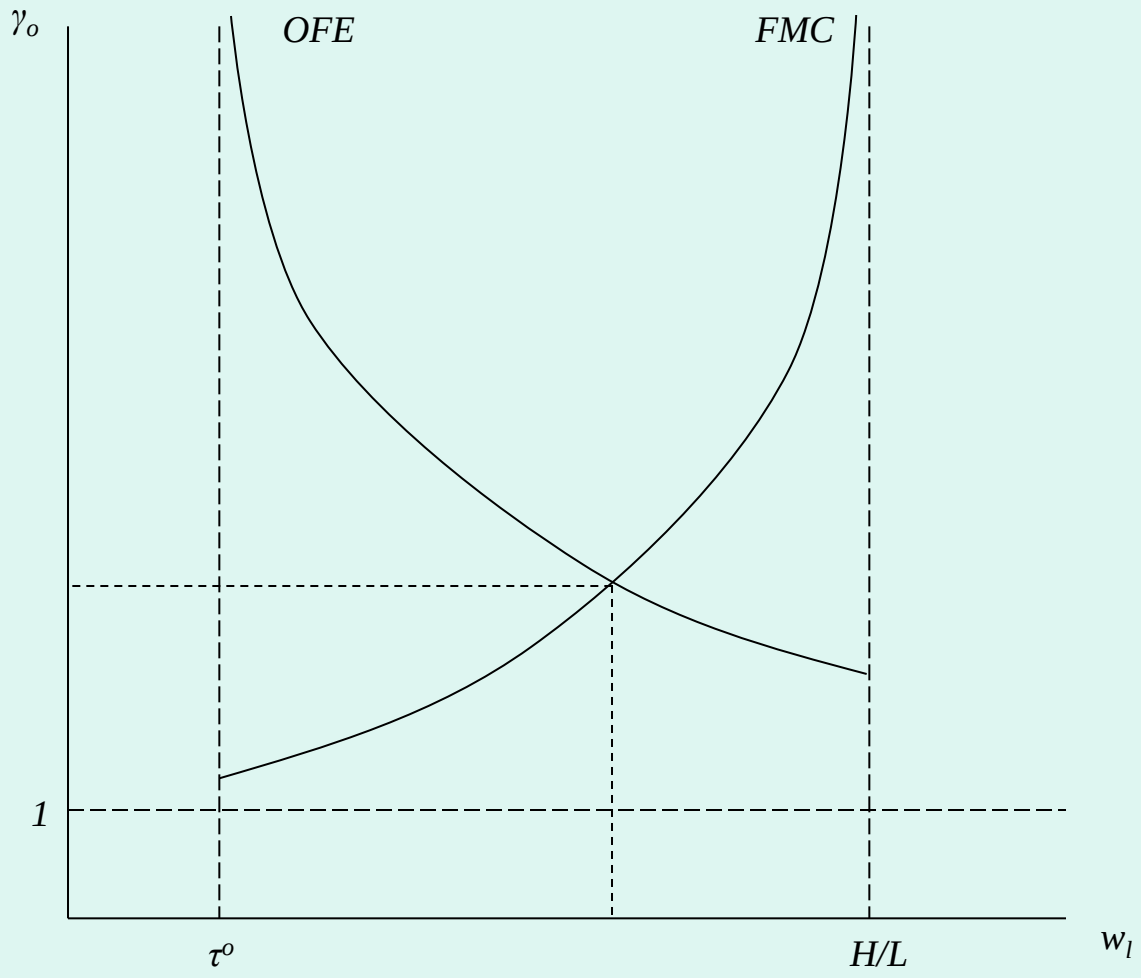
  - For $\gamma_o \to \infty$, $w_l \to H/L$: if no firm offshores, the relative wage matches its equilibrium value for the case with prohibitive offshoring costs.

- **OFE:** under the (sufficient) condition $[(a-\sigma+1)f^o]/[(\sigma-1)f^e] < 1$, **negative relationship between γ_o and w_l.** The higher the relative factor price w_l, the more home firms find it optimal to offshore.

  - $w_l \to \tau^o$ is associated with $\gamma_o \to \infty$: for a relative wage $w_l = \tau^o$, no firm finds it optimal to offshore if $f^o > 0$.

➔ There is a unique equilibrium in $[w_l \times \gamma_o | \ \tau^o < w_l < H/L, \ 1 < \gamma_o < \infty]$.

Equilibrium



Three-country, many-good model

Similar assumptions except:

- Firms make varieties of final goods by assembling a continuum of intermediate inputs:

$$q(\gamma) = \gamma \exp\left[\int_0^1 \ln[x(z)]dz\right]$$

- Intermediate inputs are produced with skilled and unskilled labor. Skill intensity increasing in z.

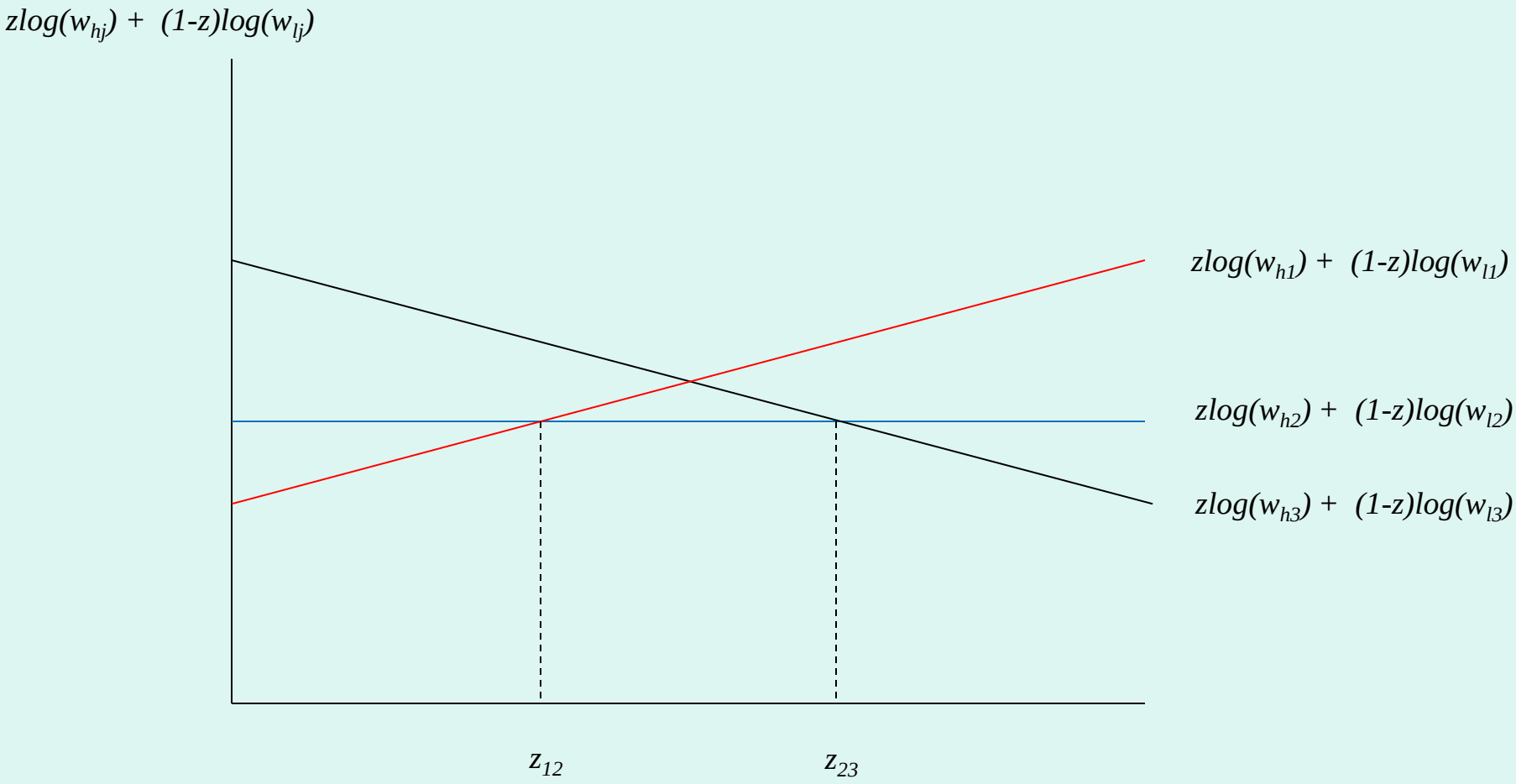
$$y(z) = \left[\frac{h(z)}{z}\right]^z \left[\frac{l(z)}{1-z}\right]^{1-z}$$

- There is a fixed cost f^o in terms of the numéraire (the final aggregate good Q) per offshored intermediate input. (Here $\tau^o = 1$).

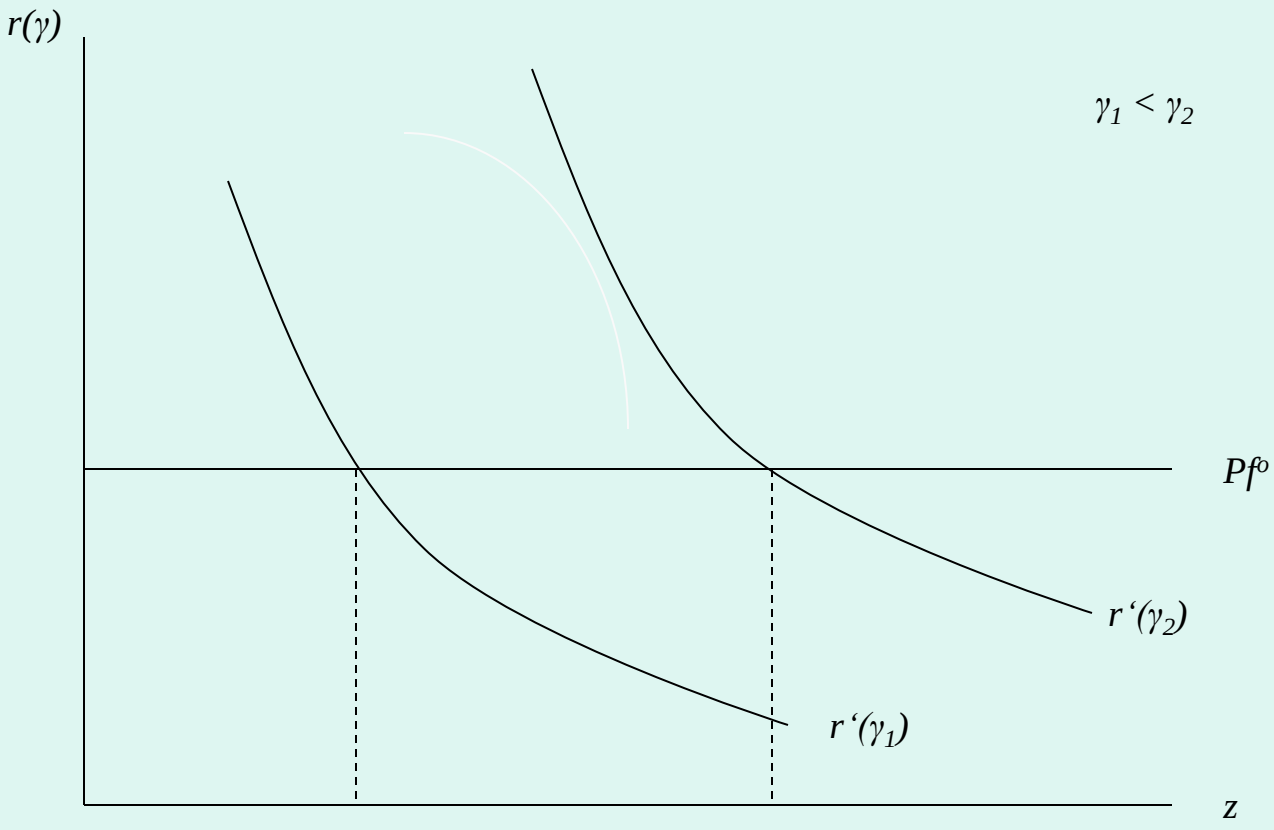
Three-country, many-good model

- Three countries with symmetric factor endowments:
  - $H_1 = L_3 < 1, L_1 = H_3 > 1, L_1 + H_1 = L_3 + H_3 = 2$
  - $H_2 = L_2 = 1$
- Symmetry implies:
  - $w_{l1} = w_{h3} < 1$
  - $w_{l3} = w_{h1} > 1$
  - $w_{l2} = w_{h2} = 1$ (numéraire)
- Firms now decide about a critical value $z(\gamma)$ that separates the ranges of offshored and in-house-produced intermediates.

Three-country, many-good model



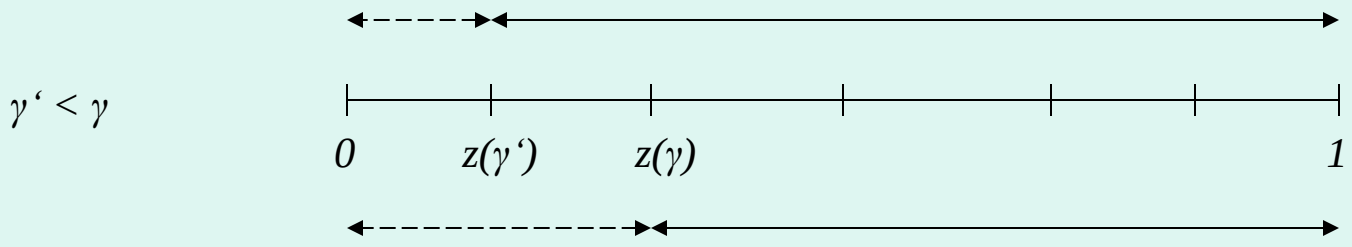
Three-country, many-good model



$$\pi(\gamma) = p(\gamma)q(\gamma) - MC(\gamma)q(\gamma) - z(\gamma)Pf^o = r(\gamma) - z(\gamma)Pf^o$$

Three-country, many-good model

- Offshored ranges of intermediate inputs:



Inputs offshored by country-3 firm with productivity γ.

Inputs produced by country-3 firm with productivity γ.

- Additional predictions:
  - More productive firms offshore more skill-intensive inputs.
  - There is a positive correlation between the skill content of imports and the skill intensity of domestic production.

Predictions

1. Significant variation in skill intensity across firms within a given (4-digit) sector. This variation is larger for importers than for other firms.

2. For French importers from labor-abundant countries the average skill intensity of imports is increasing in productivity.

3. More productive French firms import a more skill-intensive mix of products by (labor-abundant) country.

4. More productive French firms import from relatively more skill-abundant countries (out of the set of labor-abundant countries)

5. French importers from labor-abundant countries are on average more skill intensive than other firms.

6. Firm-level skill intensity is increasing in the skill intensity of imports from labor-abundant countries.

Data

- Trade at firm-level (customs data): Firm-level imports and exports broken down by country and HS6 product.

- "BRN" dataset. Administrative balance sheet dataset, exhaustive for medium and large firms.

- Skill structure at firm level. "DADS": occupational structure for all French firms with at least one employee. Provides number of jobs of each of seven categories (from managers to blue collars). Skill ratio = non blue collar/blue collar employment

- Skill content of imports: constructed using US industry-level data and firm-product level imports. Skill intensity of imports: $s_{ft} = \sum w_{ift} s_i$

- $s_{i:}$ skill intensity of product *i*. w_{ift}: share of product *i* in imports of *f*.

Estimating sample

- Panel of 104,436 firms with data on TFP (Levinsohn-Petrin method), employment, imports by product & source country, capital/labor ratios and skill intensities of production (= skill ratio) for 1996-2007.

- Look at importing from two sets of countries: less than 95 % of French level of secondary education and less than 80% of French level (excluding ‘old’ EU member countries)

Empirical prediction 2

For French importers from labor-abundant countries the average skill intensity of imports is increasing in productivity.

$$skill\_content_{f,t} = \beta_0 + \beta_1 \log(TFP)_{f,t-1} + \beta_2 X_{f,t} + \epsilon_{f,t}$$

Importing from labor-abundant countries and firm-level TFP

Table 3: Importing from labor-abundant countries: skill content of imports and productivity

	Dependent variable is skill content of imports$_{ft}$ from countries ≤ 80 percent of French sec. schooling				from countries ≤ 95 percent of French sec. schooling			
	(1)	(3)	(2)	(4)	(5)	(6)	(7)	(8)
log(TFP)$_{f,t-1}$	**0.0058*** **	**0.0029***	**0.0039** **	**0.0031***	**0.0086*** **	**0.0052*** **	**0.0045*** **	**0.0037** **
	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)
log(employees)$_{f,t}$		-0.0028***		0.0012		-0.0032***		0.0027
		(0.001)		(0.002)		(0.001)		(0.002)
log(capital/labor)$_{f,t}$		0.0023***		0.0025		0.0021***		0.0021
		(0.001)		(0.002)		(0.001)		(0.002)
log(exports)$_{f,t}$		-0.0003		0.0007		-0.0007**		0.0005
		(0.000)		(0.001)		(0.000)		(0.000)
log(imports)$_{f,t}$		0.0035***		0.0019**		0.0046***		0.0017**
		(0.001)		(0.001)		(0.001)		(0.001)
Observations	48,340	48,340	48,340	48,340	55,333	55,333	55,333	55,333
Firms	12,047	12,047	12,047	12,047	13,297	13,297	13,297	13,297
Firm FE	NO	NO	YES	YES	NO	NO	YES	YES
4-digit Sector FE	YES	YES	NO	NO	YES	YES	NO	NO
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
R-squared	0.3258	0.3279	0.0057	0.0061	0.3152	0.3183	0.0042	0.0046

Empirical predictions 3 and 4

3. More productive French firms import a more skill-intensive mix of products by (labor-abundant) country.

$$\log(imports)_{f,p,c,t} = \beta_0 + \beta_1 \log(TFP)_{f,t} + \beta_2 skillint_p + \\ + \beta_3 \log(TFP)_{f,t} * skillint_p + \beta_4 X_{f,c,t} + \theta_c + \epsilon_{f,p,c,t}.$$

4. More productive French firms import from relatively more skill-abundant countries (out of the set of labor-abundant countries)

$$\log(imports)_{f,p,c,t} = \beta_0 + \beta_1 \log(TFP)_{f,t} + \beta_2 sec.schooling_c + \\ + \beta_3 \log(TFP)_{f,t} * sec.schooling_c + \beta_4 X_{f,c,t} + \epsilon_{f,p,c,t},$$

Importing from labor-abundant countries: the relation between firm-level TFP, product-level skill intensity and country-level skill abundance.

Table 4: Importing from labor-abundant countries: productivity, product-level skill intensity and countries' skill abundance

	dependent variable is $\log(\text{imports})_{fcpt}$							
	countries ≤ 80 percent of French sec. schooling		countries ≤ 95 percent of French sec. schooling		countries ≤ 80 percent of French sec. schooling		countries ≤ 95 percent of French sec. schooling	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\log(\text{TFP})_{f,t}$	-0.4867***	-0.4181***	-0.4522***	-0.3976***	-0.3211***	-0.3515***	-0.3884***	-0.4054***
	(0.031)	(0.027)	(0.028)	(0.024)	(0.033)	(0.025)	(0.032)	(0.026)
skill intensity$_p$	-2.4973***	-1.6618***	-2.4031***	-1.7298***				
	(0.417)	(0.309)	(0.375)	(0.293)				
$\log(\text{TFP})_{f,t}$*	**0.6965*** **	**0.4188*** **	**0.6754*** **	**0.4421*** **				
skill intensity$_p$	(0.107)	(0.078)	(0.095)	(0.073)				
sec. schooling$_c$					-0.3090	-0.2016	-1.0045***	-0.6871***
					(0.208)	(0.193)	(0.191)	(0.223)
$\log(\text{TFP})_{f,t}$*					**0.0696**	**0.0963***	**0.2523*** **	**0.2302*** **
sec. schooling$_c$					(0.054)	(0.049)	(0.053)	(0.060)
$\log(\text{employees})_{f,t}$		0.0152*		0.0199**		0.0146*		0.0184**
		(0.008)		(0.008)		(0.009)		(0.008)
$\log(\text{capital/labor})_{f,t}$		-0.0647***		-0.0574***		-0.0624***		-0.0534***
		(0.011)		(0.010)		(0.011)		(0.010)
$\log(\text{exports})_{f,t}$		0.6256***		0.6286***		0.6305***		0.6336***
		(0.010)		(0.009)		(0.009)		(0.008)
Observations	1,995,166	1,995,166	2,624,397	2,624,397	2,056,312	1,979,406	2,693,558	2,359,966
Country FE	YES	YES	YES	YES	NO	NO	NO	NO
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
Gravity Controls	NO	NO	NO	NO	NO	YES	NO	YES
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
R-squared	0.0216	0.1180	0.0168	0.1117	0.0215	0.1174	0.0171	0.1134

Empirical prediction 5

5. French importers from labor-abundant countries are on average more skill intensive than other firms.

$$\log(skillratio)_{f,t} = \beta_0 + \beta_1 ImportsBelowThreshold_{f,t} + \\ + \beta_2 ImportsAboveThreshold_{f,t} + \beta_3 X_{f,t} + \epsilon_{f,t},$$

Importing from labor-abundant countries and skill-intensity of production in France (extensive margin)

Table 5: Skill ratio of production and imports from labor-abundant countries: extensive margin

	dependent variable is log(skill ratio)$_{ft}$							
	countries ≤ 80 percent of French sec. schooling				countries ≤ 95 percent of French sec. Schooling			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
import status	**0.1980*** **	**0.2517*** **	**0.0429*** **	**0.0474*** **	**0.1996*** **	**0.2497*** **	**0.0388*** **	**0.0437*** **
below threshold$_{f,t}$	(0.010)	(0.009)	(0.004)	(0.004)	(0.009)	(0.009)	(0.004)	(0.004)
import status	-0.0260***	0.0032	-0.0121***	0.0029	-0.0349***	-0.0034	-0.0124***	0.0024
above threshold$_{f,t}$	(0.006)	(0.006)	(0.003)	(0.003)	(0.006)	(0.006)	(0.003)	(0.003)
log(TFP)$_{f,t}$		0.3925***		-0.0112***		0.3919***		-0.0112***
		(0.006)		(0.004)		(0.006)		(0.004)
log(employees)$_{f,t}$		-0.1801***		-0.1708***		-0.1805***		-0.1709***
		(0.003)		(0.005)		(0.003)		(0.005)
log(capital/labor)$_{f,t}$		0.0237***		-0.0183***		0.0235***		-0.0183***
		(0.003)		(0.004)		(0.003)		(0.004)
export status$_{f,t}$		0.1410***		0.0156***		0.1386***		0.0157***
		(0.006)		(0.003)		(0.006)		(0.003)
Observations	646,920	646,920	646,920	646,920	646,920	646,920	646,920	646,920
Firms	104,036	104,037	104,038	104,039	104,040	104,041	104,042	104,043
Firm FE	NO	NO	YES	YES	NO	NO	YES	YES
4-digit sector FE	YES	YES	NO	NO	YES	YES	NO	NO
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
R-squared	0.2037	0.2508	0.0040	0.0112	0.2039	0.2510	0.0040	0.0111

Importing from labor-abundant countries and skill-intensity of production in France (intensive margin)

Table 6: Skill ratio of production and imports from labor-abundant countries: intensive margin

	dependent variable is log(skill ratio)$_{ft}$							
	countries ≤ 80 percent of French sec. schooling		countries ≤ 95 percent of French sec. schooling		countries ≤ 80 percent of French sec. schooling		countries ≤ 95 percent of French sec. schooling	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
imports/sales	**0.2659****	**0.2487****	**0.2500*****	**0.2352*****	**0.2325****	**0.1853***	**0.2152****	**0.1697****
below threshold$_{f,t}$	(0.109)	(0.102)	(0.096)	(0.090)	(0.113)	(0.095)	(0.099)	(0.083)
imports/sales	-0.0086	-0.0082	-0.0086	-0.0083	-0.0245	-0.0368**	-0.0231	-0.0346**
above threshold$_{f,t}$	(0.006)	(0.006)	(0.006)	(0.006)	(0.016)	(0.016)	(0.016)	(0.017)
log(TFP)$_{f,t}$		-0.0124***		-0.0124***		-0.0011		0.0048
		(0.004)		(0.004)		(0.012)		(0.011)
log(employees)$_{f,t}$		-0.1721***		-0.1721***		-0.2407***		-0.2365***
		(0.005)		(0.005)		(0.026)		(0.024)
log(capital/labor)$_{f,t}$		-0.0186***		-0.0186***		-0.0463***		-0.0481***
		(0.004)		(0.004)		(0.017)		(0.016)
log(exports)$_{f,t}$		0.0077***		0.0077***		0.0106***		0.0107***
		(0.001)		(0.001)		(0.004)		(0.004)
Observations	646,920	646,920	646,920	646,920	49,613	49,613	55,719	55,719
Firms	104,036	104,036	104,036	104,036	11,763	11,763	12,714	12,714
Sample	all	all	all	all	importers	importers	importers	importers
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
R-squared	0.0042	0.0114	0.0042	0.0114	0.0509	0.0660	0.0465	0.0612

Empirical prediction 6

6. Firm-level skill intensity is increasing in the skill intensity of imports from labor-abundant countries

$$\log(skillratio)_{f,t} = \beta_+ \beta_1 skill\_content_{f,t} + \beta_2 X_{f,t} + \epsilon_{f,t},$$

Skill intensity of production in France and skill content of imports from labor-abundant countries

dependent variable is $\log(\text{skill ratio})_{f,t}$								
countries ≤ 80 percent of French sec. schooling				countries ≤ 95 percent of French sec. schooling				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
skill content	**0.9538*** **	**0.8678*** **	**0.0754***	**0.0725***	**0.9655*** **	**0.9001*** **	**0.0900****	**0.0936****
imports$_{f,t}$	(0.084)	(0.078)	(0.041)	(0.041)	(0.079)	(0.073)	(0.040)	(0.039)
$\log(\text{TFP})_{f,t}$		0.5262***		-0.0040		0.5273***		0.0008
		(0.015)		(0.010)		(0.015)		(0.009)
$\log(\text{employees})_{f,t}$		-0.2055***		-0.2502***		-0.2101***		-0.2425***
		(0.008)		(0.018)		(0.008)		(0.017)
$\log(\text{capital/labor})_{f,t}$		-0.0553***		-0.0563***		-0.0580***		-0.0579***
		(0.008)		(0.012)		(0.008)		(0.011)
$\log(\text{imports})_{f,t}$		0.0560***		0.0128***		0.0557***		0.0106***
		(0.004)		(0.004)		(0.004)		(0.004)
$\log(\text{exports})_{f,t}$		0.0376***		0.0088***		0.0362***		0.0094***
		(0.003)		(0.003)		(0.003)		(0.003)
Observations	49,613	49,613	49,613	49,613	55,719	55,719	55,719	55,719
Firms	11,763	11,763	11,763	11,763	12,714	12,714	12,714	12,714
Firm FE	NO	NO	YES	YES	NO	NO	YES	YES
4-digit sector FE	YES	YES	NO	NO	YES	YES	NO	NO
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
R-squared	0.2600	0.3373	0.0350	0.0513	0.2603	0.3378	0.0307	0.0461

Instrumental variables

- Comparative statics: a reduction in offshoring costs vis-à-vis labor-abundant countries leads to offshoring of more skill-intensive intermediate inputs and skill-upgrading of firms' production in France.

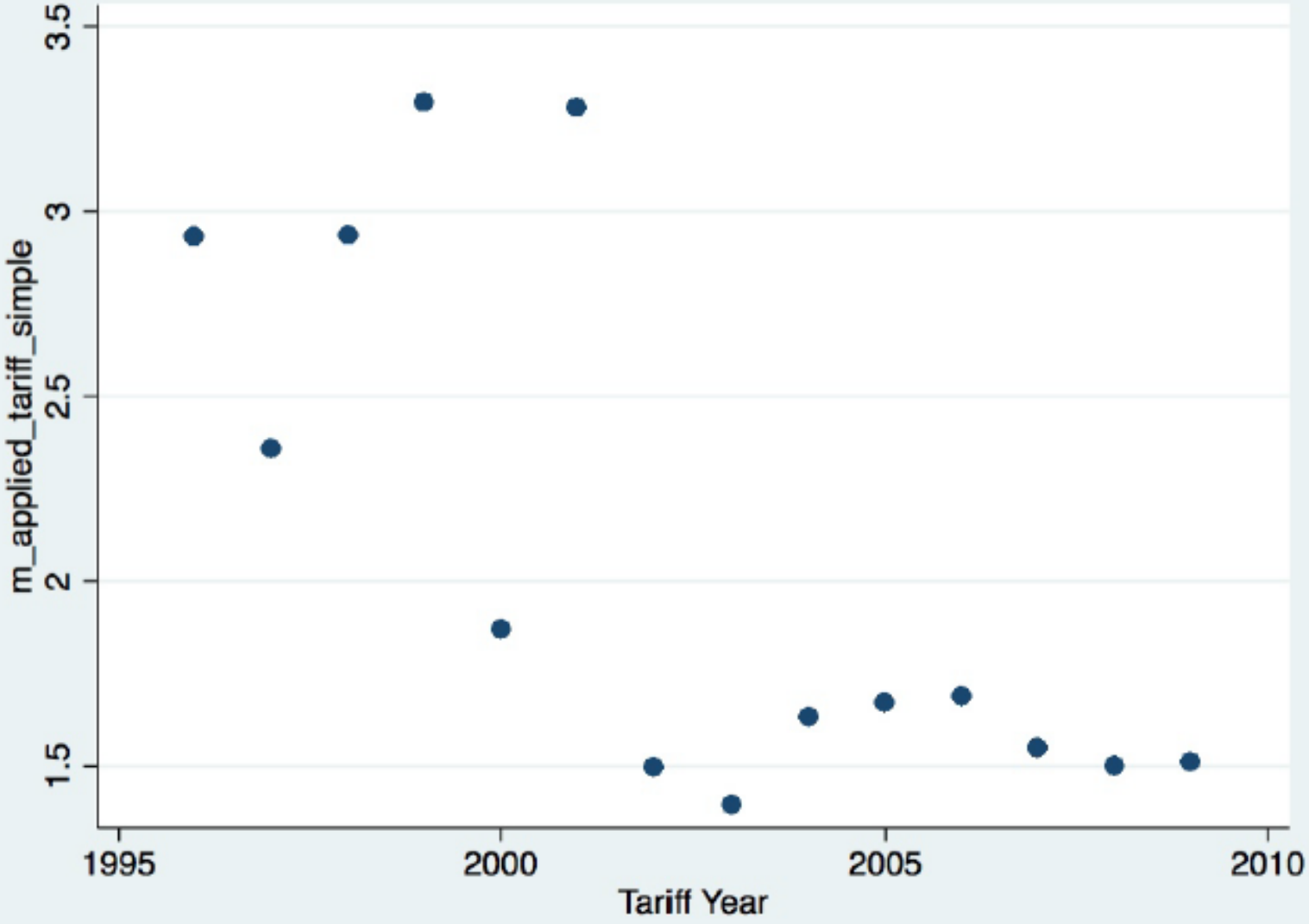
- Uruguay round of multilateral trade liberalisation (1994): the EU reduced its applied most-favoured-nation tariffs in manufacturing by around 3 percentage points. Most of these tariff reductions were implemented in the late 1990s.

- During the same period, substantial bilateral tariff reductions took place with several Eastern European countries.

- The EU also signed several bilateral free trade agreements during our sample period which lead to further tariff reductions.

- We consider applied bilateral tariffs at the HS6 level.

EU average manufacturing tariffs



Instrumental variables

- We regress the log value of imports of product *i* by firm *f* from country *c* on log(1+tariff$_{ict}$) and firm-, product-, and country- fixed effects.

- Obtain predicted imports log(imports$_{fict}$). These are import values explained by firm-, product-, country-means and tariffs.

- We sum this across countries, to obtain a firm-product-time-specific weight

$$\hat{w}_{fit} = \sum_{c} imports_{fict} \Big/ \sum_{i} \sum_{c} imports_{fict}$$

- Finally, we multiply these weights with product-specific skill intensities and sum over products to obtain the predicted skill content of imports.

$$\hat{s}_{ft} = \sum_{i} \hat{w}_{fit} s_i$$

Firm-level skill intensity and skill contents of imports (IV)

Dependent variable is the skill ratio of production in France, skill content of imports from labor-abundant countries

dependent variable is $\log(\text{skill ratio})_{f,t}$								
	countries $\leq$ 80 percent of French sec. schooling			countries $\leq$ 95 percent of French sec. schooling				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
skill content imports$_{f,t}$	**1.4550*****	**1.3405*****	**0.3469***	**0.3564***	**1.4919*****	**1.3895*****	**0.4184****	**0.4078****
	(0.197)	(0.181)	(0.192)	(0.190)	(0.184)	(0.169)	(0.185)	(0.183)
$\log(\text{TFP})_{f,t}$		0.5333***		-0.0101		0.5442***		-0.0079
		(0.022)		(0.014)		(0.020)		(0.013)
$\log(\text{employees})_{f,t}$		-0.1940***		-0.2794***		-0.1953***		-0.2635***
		(0.011)		(0.029)		(0.011)		(0.026)
$\log(\text{capital/labor})_{f,t}$		-0.0546***		-0.0626***		-0.0596***		-0.0602***
		(0.012)		(0.019)		(0.011)		(0.017)
$\log(\text{imports})_{f,t}$		0.0660***		0.0298***		0.0628***		0.0294***
		(0.007)		(0.007)		(0.007)		(0.006)
$\log(\text{exports})_{f,t}$		0.0364***		0.0061		0.0346***		0.0059
		(0.005)		(0.004)		(0.004)		(0.004)
Observations	42,456	42,456	39,527	39,527	49,230	49,230	46,063	46,063
Firms	7,833	7,833	7,833	7,833	8,854	8,854	8,854	8,854
Firm FE	NO	NO	YES	YES	NO	NO	YES	YES
4-digit Sector FE	YES	YES	NO	NO	YES	YES	NO	NO
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
Cluster	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
R-squared	0.2431	0.3227	0.0457	0.0634	0.2450	0.3239	0.0390	0.0556
First-stage regression: dependent variable is skill content of imports$_{f,t}$								
tariff-predicted skill content imports$_{f,t}$	**0.7442*****	**0.7405*****	**0.4153*****	**0.4147*****	**0.7452*****	**0.7486*****	**0.3806*****	**0.3802*****
	(0.011)	(0.011)	(0.022)	(0.022)	(0.010)	(0.010)	(0.019)	(0.019)
F-statistic	4366.68	4366.76	359.69	375.75	5151.24	5198.95	420.43	418.98

Conclusions

- Have developed a model of offshoring with firm heterogeneity and Heckscher-Ohlin features
- Can explain intra-industry heterogeneity in firm-level factor proportions.
- Reduction in offshoring costs leads to endogenous skill deepening (looks like skill-biased technological change).
- We provide empirical evidence on the microeconomic channels of the effect of offshoring on firm-level skill upgrading in line with the model's prediction.

Appendix

Comparative statics

- An increase in f^o shifts the OFE-schedule upwards, thus leading to a higher γ_o and a higher w_l.

  Intuition: a higher f^o makes offshoring non profitable for some firms; this raises the relative demand for labor, thus raising w_l.

- An increase in τ^o shifts the OFE-schedule upwards (a higher τ^o reverses the profitability of offshoring for some firms), and the FMC-schedule to the right (for a given γ_o, the relative demand for the scarce factor rises, as offshoring is now subject to a higher variable cost). Thus, an increase in τ^o raises w_l. The effect on γ_o is also unambiguously positive: the vertical upward shift of the OFE-schedule dominates the shift of the FMC-schedule in the opposite direction.

Comparative statics

- An increase in H/L shifts the FMC-schedule to the right, thus leading to a lower γ_o and a higher w_l.

  Intuition: a higher H/L makes labor relatively more scarce; this raises the relative price of labor, and makes offshoring profitable for firms with lower productivity levels.

- An increase in f^e shifts the OFE-schedule downwards, thus leading to a lower γ_o and a lower w_l.

  Intuition: the higher f^e, the less firms in the market; this raises the price level P, and makes firms larger (in terms of sales); therefore it pays off for more firms to offshore, thus leading to downward pressure on w_l.