Offshoring and Firm Overlap

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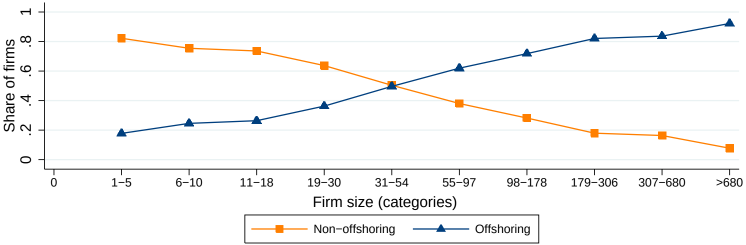
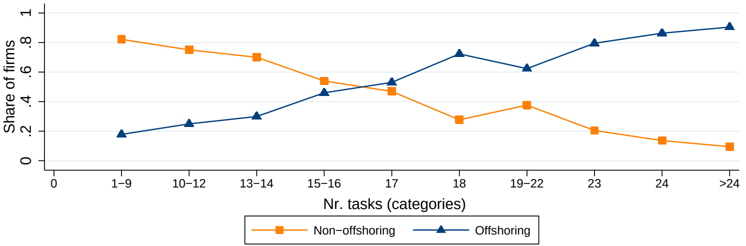
Motivation

- Offshoring features prominently in the public debate as well as the scientific research on international trade
- Recent contributions focus on the role of firm heterogeneity:
  - Antràs and Helpman (2004)
  - Antràs, Garicano and Rossi-Hansberg (2006)
  - Egger, Kreickemeier and Wrona (2013)
- In heterogeneous firms models à la Melitz (2003) with fixed offshoring costs:
  - $\Rightarrow$ Firms self-select into offshoring
  - $\Rightarrow$ Direct link between firm size and offshoring status
- But considerable overlap in the data: firms with the same size (or productivity) have different offshoring intensities

Motivation



Share of firms
0
.2
.4
.6
.8
1
0
1−5
6−10
11−18
19−30
31−54
55−97
98−178
179−306
307−680
>680
Firm size (categories)
Non−offshoring
Offshoring



Share of firms
0
.2
.4
.6
.8
1
0
1−9
10−12
13−14
15−16
17
18
19−22
23
24
>24
Nr. tasks (categories)
Non−offshoring
Offshoring

Motivation

Table: Firm size and offshoring

Size (IAB)	No	Yes
1-5	*82.21*	*17.69*
6-10	*75.43*	*24.57*
11-18	*73.84*	*26.16*
19-30	*62.47*	*37.53*
31-54	*47.12*	*52.88*
55-97	*36.56*	*63.44*
98-178	*26.31*	*73.69*
179-306	*17.03*	*82.97*
307-680	*16.10*	*83.90*
$>$ 680	*6.76*	*93.24*
Total	*45.93*	*54.07*

Table: Nr. of tasks and offshoring

Nr. tasks	No	Yes
1-9	82.91	17.09
10-12	76.65	23.35
13-14	68.00	32.00
15-16	56.86	43.14
17	52.36	47.64
18	30.77	69.23
19-22	45.44	54.56
23	24.92	75.08
24	16.69	83.31
$>$ 24	11.58	88.42
Total	69.29	30.71

Motivation

- Stylized facts show:
  - subset of firms of each category engages in offshoring
  - share increases in firm size/number of tasks
- In Melitz-type models overlap requires the draw of two (dependent) random variables (Davis and Harrigan, 2011; Harrigan and Reshef, *forthcoming*)
- So far missing: clean microfoundation of overlap

This paper

Theory

- *Tractable* model of offshoring and firm overlap
- New microfoundation: firms differ
  - in the range of tasks they perform, and
  - in the share of offshorable tasks

  $\Longrightarrow$ Probability of offshoring increases in the number of tasks

Empirics

- Model-based estimation of key parameters
- Quantifying the welfare effects of offshoring
- Conducting counterfactual analysis

The model

Basic assumptions

- 2 countries, L (developed, source) and L^* (undeveloped, host)
- Consumers in both countries have identical CES preferences
- Monopolistic competition among single-product firms
- Production requires performance of different tasks, combined into a Cobb-Douglas technology

$$q = \frac{z}{1-z} \exp\left[\frac{1}{z}\int_0^z \ln x(i) di\right], \tag{1}$$

  - $x(i)$ output for task i, which equals labor input
  - $z \in (0, 1)$ firm-specific number of tasks

The model

Cost minimization

- Two modes of production:
  - $c^d = (1-z)w$, if all tasks are performed at home
  - $c^o = (1-z)w\kappa^s$, if share s is performed offshore

  Where:
  - $\kappa \equiv \tau w^*/w$ is the effective wage differential

- Offshoring only attractive if $\kappa < 1$

- $1/\kappa^s$ is the marginal *cost saving effect* of offshoring

The model

Firm entry

- Entering requires an initial investment of f_e units of labor
- Investment gives single draw from a lottery
- Outcome is a technology tuple (z, s)
  - z: number of tasks,

    $$f_z(z) = k(1-z)^{k-1}$$

  - s: share of offshorable tasks,

    $$s \sim U(0,1)$$

- After the lottery, firms only know z but are uninformed about s

The model

Firm entry

- Firms form expectations on s:
  - Probability of $s > 0$ is a positive function of z
  - For tractability, we set this probability equal to z
- Firms can invest f units of labor into a fixed offshoring service, which provides information on the share s of offshorable tasks

  $\Rightarrow$ **Intuition:** Firms have to go through an in-depth analysis of their offshoring potential

- At $\hat{z}$ a firm is indifferent between investing f or not

The model

Illustration

f_e

draw (z, s) while only z is revealed

$z < \hat{z}$ → no investment, $f = 0$

$z > \hat{z}$ → investment in off. service, $f > 0$

no investment, $f = 0$:

$\underline{s = ?}$

$c^d = (1 - z)w$

$p = \frac{\sigma}{\sigma - 1} c^d$

$\pi = pq$

investment in off. service, $f > 0$, with probability $1 - z$:

$\underline{s = 0}$

$c^d = (1 - z)w$

$p = \frac{\sigma}{\sigma - 1} c^d$

$\pi = pq - f$

investment in off. service, $f > 0$, with probability z:

$\underline{s \geq 0}$

$c^o = (1 - z)w\kappa^s$

$p = \frac{\sigma}{\sigma - 1} c^o$

$\pi = pq - f$

The model

Equilibrium

- *Offshoring indifference condition* (OC):

$$\Gamma_1(\hat{c},\kappa) = \frac{\hat{c}^{\sigma-1}}{1-\hat{c}}\frac{k}{k-\sigma+1} + \left\{\frac{\hat{c}^k}{1-\hat{c}}\left[\frac{\sigma-1}{k-\sigma+1} - \hat{c}\frac{\sigma-2}{k-\sigma+2}\right] - \frac{f_e}{f}\right\}\left[\frac{\kappa^{1-\sigma}-1}{(1-\sigma)\ln\kappa} - 1\right] = 0.$$

$\rightarrow$ establishes a negative link between $\hat{c}$ and κ

- *Labor market constraint* (LC):

$$\Gamma_2(\kappa,\hat{c}) \equiv \kappa\left\{\frac{\sigma+1}{\sigma-1} + \frac{2\sigma}{\sigma-1}\frac{(1-\sigma)\ln\kappa}{\kappa^{1-\sigma}-1}\left[\frac{k-\sigma+2}{\hat{c}^{k-\sigma+1}\left[1+(1-\hat{c})(k-\sigma+1)\right]} - 1\right]\right\} - \frac{\tau L}{L^*} = 0.$$

$\rightarrow$ establishes a positive link between $\hat{c}$ and κ

- System of two equations which jointly determine a unique interior equilibrium with $\hat{c},\kappa \in (0,1)$

Equilibrium values of $\hat{c}$ and $\kappa = \tau w^*$

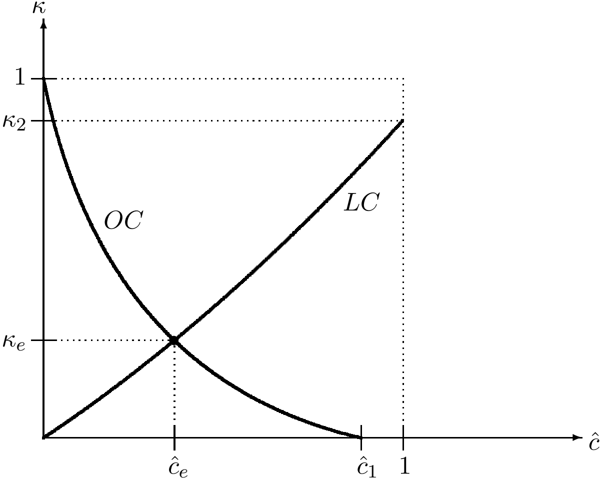


Figure: Equilibrium values of $\hat{c}$ and κ

Comparative statics: increase in f

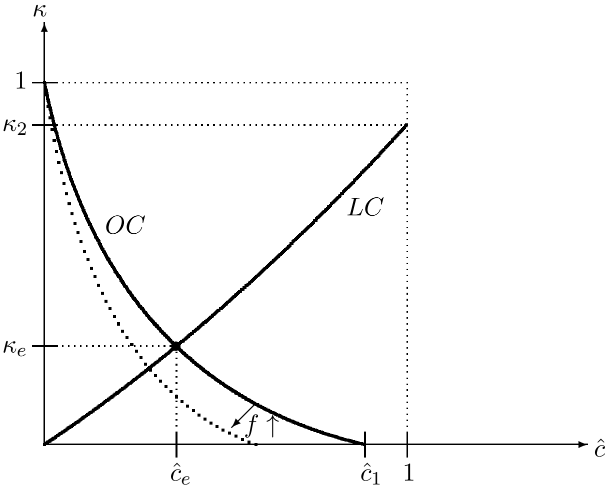


Figure: Equilibrium values of $\hat{c}$ and κ

Comparative statics: increase in τ

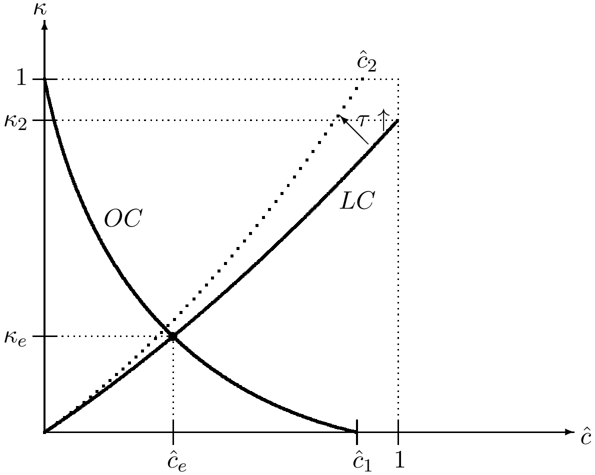


Figure: Equilibrium values of $\hat{c}$ and κ

Data source

- German manufacturing establishments: years 1999, 2001, 2003
- 29 tasks from BIBB-BAuA 2006 survey

- Sample selection: large manufacturing firms (i.e., $4 employees$)

Table: Summary statistics

	Mean	Median	Std. Dev.
Offshoring	0.38	0.00	0.49
Nr. of tasks	13.98	14.00	4.18
Nr. of tasks/total nr. tasks	0.48	0.48	0.14
Revenues	9,420,030	1,186,826	98,268,970

Method of Moments estimation

Estimating k and $\hat{c}$

- Targeted moments: share of offshoring firms χ, first and second moments of $1 - z$
- Method of Moments (minimum-distance) constrained estimation

$$
\begin{aligned}
0 &\approx \chi_o - \left\{ \hat{c}^k \left[1 - \frac{k}{k+1} \hat{c} \right] \right\} \quad , \\
0 &\approx \tilde{c}_o - \left\{ \frac{k}{k+2} \hat{c}^{k+2} + \frac{k}{k+1} - \frac{k}{k+1} \hat{c}^{k+1} \right\} \quad , \\
0 &\approx v_o - \left\{ \frac{k}{k+3} \hat{c}^{k+3} + \frac{k}{k+2} - \frac{k}{k+2} \hat{c}^{k+2} - [\tilde{c}(k, \hat{c})]^2 \right\}
\end{aligned}
$$

Method of Moments estimation

Estimating σ and $r(1)$

- We use

$$\ln r^d(1-z) = \ln r^d(1) + (1-\sigma)\ln(1-z) \tag{2}$$

- And combine the OLS and FE moment conditions for identification

$$\zeta_1 = E\left[\ln r^d - \ln r_1^d - (1-\sigma)\ln(1-z)\right] = 0,$$

$$\zeta_2 = E\left[\ln r^d - \ln r_1^d - (1-\sigma)\ln(1-z)\right]\ln(1-z) = 0$$

$$\zeta_3 = E\left[\Delta\ln r^d - (1-\sigma)\Delta\ln(1-z)\right] = 0,$$

$$\zeta_4 = E\left[\Delta\ln r^d - (1-\sigma)\Delta\ln(1-z)\right]\Delta\ln(1-z) = 0$$

Results

Parameter values

	$\hat{c}$	k	χ	$\tilde{c}$	var(c)
Estimates	0.996	1.653	0.377	0.452	0.150
Targets			0.384	0.555	0.016
Difference			0.007	0.103	0.134

	σ	$r^d(1)$
Estimates	1.857	1,421,002

Recovered parameters: κ, f, f_E *and* $\tau L/L^*$

	κ	f	f_e	$\tau L/L^*$
Parameters	0.115	5,704.08	3,265,730	0.522

Results

Welfare effects

- We use the parameter estimates to evaluate the welfare effects of offshoring
- Using per-capita income as a welfare measure, we compute:
$$\Delta W = 100\left\{\left(1+\frac{\kappa L^*}{\tau L}\right)^{\frac{1}{\sigma-1}}\left[1-\frac{\hat{c}^k}{1-\hat{c}}\left(\frac{\sigma-1}{k-\sigma+1}-\hat{c}\,\frac{\sigma-2}{k-\sigma+2}\right)\frac{f}{f_e}\right]^{\frac{1}{1-\sigma}}-1\right\}$$
  - Welfare increases by 192.29 percent when moving from autarky to today
  - In a model variant without overlap, welfare increases by 77.95 percent

Counterfactual analysis

Changes in the offshoring fixed cost f

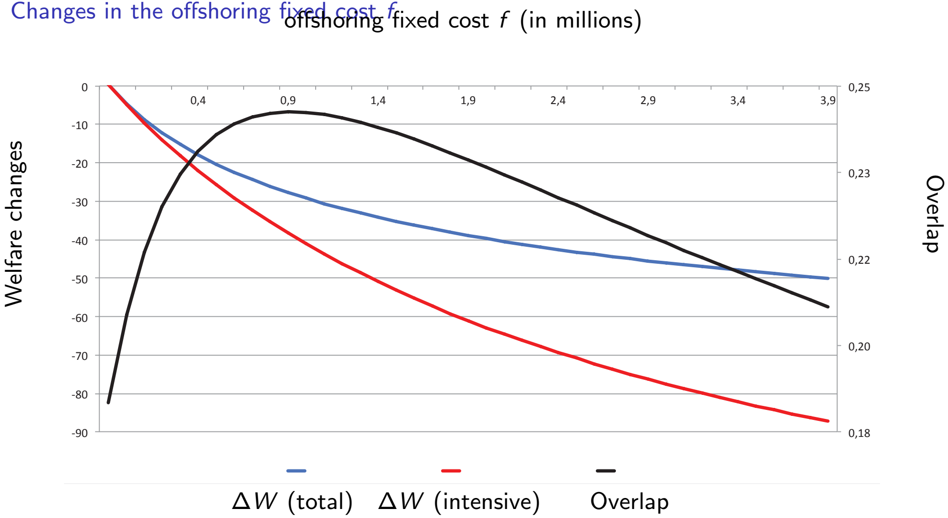
We evaluate:

- The welfare effects
  - Along the *intensive margin* of offshoring (i.e. keeping the share of offshoring firms χ constant)
  - Along the *extensive margin* of offshoring (i.e. keeping the effective wage differential κ constant)
- Effect on the overlap between offshoring and non-offshoring firms
  - Our aggregate measure of overlap is given by

$$O = \frac{1}{F_c(\hat{c})} \int_0^{\hat{c}} \left(1 - \left|1 - 2\frac{kc^k}{f_c(c)}\right|\right) f_c(c)dc \qquad (3)$$

Counterfactual analysis

Changes in the offshoring fixed cost f



Model fit

Decile	Overlap		Difference
	observed	computed	
1	0.407	0.002	0.405
2	0.49	0.012	0.478
3	0.704	0.037	0.667
4	0.907	0.103	0.804
5	0.868	0.276	0.592
6	0.774	0.744	0.031
7	0.442	0.495	-0.053
8	0.466	0.11	0.355
9	0.452	0.026	0.426
Average	0.612	0.201	0.412

Robustness checks

Table: Alternative estimation of σ

Estimated Model: $\ln r^d(1-z) = \ln r^d(1) + (1-\sigma)\ln(1-z)$			
Estimator	OLS	FE	RE
$\ln c = \ln(1-z)$	-3.022^{***}	-0.319	-2.687^{***}
	(0.077)	(0.340)	(0.096)
σ	4.022^{***}	1.318^{***}	3.687^{***}
$r(1)$	88,198	420,114	121,925
R-squared	0.503	0.965	0.503
Observations	1981	1981	1981

A model variant without overlap

- No overlap $\rightarrow$ all firms investing f actually start offshoring
- We estimate another set of model parameters based on this new assumption
- We compare the welfare effects of offshoring in the two model variants

Using per-capita income as a welfare measure, we find:

- Welfare increases by 192.29 percent in the model variant with overlap
- Welfare increases by 77.95 percent in the model variant without overlap

Results - No overlap

	$\hat{c}$	k	χ	$\tilde{c}$	var(c)
Estimates	0.529	1.525	0.307	0.555	0.154
Targets			0.384	0.555	0.016
Difference			-0.005	-0.072	-0.138

	σ	$r^d(1)$
Estimates	1.857	1,421,002

Recovered parameters: κ, f, f_E *and* $\tau L/L^*$

	κ	f	f_e	$\tau L/L^*$
Parameters	0.247	1, 229, 820	2, 345, 320	1.118

Conclusions

Summary:

- Tractable model which matches the overlap between offshoring and non-offshoring firms
- Model-based estimation using German firm-level data
- Evaluation of the welfare effects and counterfactual analysis

Main findings:

- Offshoring exerts a welfare stimulus
- Taking into account the overlap magnifies the welfare effects of offshoring

In progress:

- More flexible structure for the correlation between number of tasks and the share of offshorable tasks