Offshoring and Segregation by Skill: Theory and Evidence

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Introduction

Production of a final good involves multiple tasks/occupations

Globalization and ICT development have facilitated the fragmentation of production process across borders: **offshoring**

- A new paradigm of global trade (Grossman and Rossi-Hansberg, 2006)
- Involves reorganizing production → Negative effects on high-offshorable jobs (Hummels et al. 2014, Bernard et al. 2023)

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We study the effects of offshoring on firm's demand for skills and the reallocation of workers across firms *within* high-offshorable occupations

- Changes in worker-firm matching domestically
- Implications for Between-firm inequality
  (Card, Heining, Kline, 2013; Bagger and Lentz, 2019;
  Song, Price, Guvenen, Bloom, Wachter, 2019)

Offshoring

1. Concept
   - Firms' choice to match with foreign workers instead of home workers
2. Data/Measurement
   - "Narrow Offshoring": sum of imports in same HS6 category as firm production:
     (i) utilized in the production process
     (ii) potentially substitute in-house workers
3. Focus
   - China, Low wage countries (Bernard, Jensen and Schott, 2006)

This Paper

Empirical Analysis Use the Danish administrative data (1996-2006)

✓ Offshoring reduces between firms variance of skills within offshorable occupations.
✓ Offshoring improves the average skills of in-house workers in offshorable occupations

- Small adjustments through skill updates
- Compositional changes in in-house workers are important
- More pronounced effects on low-type firms

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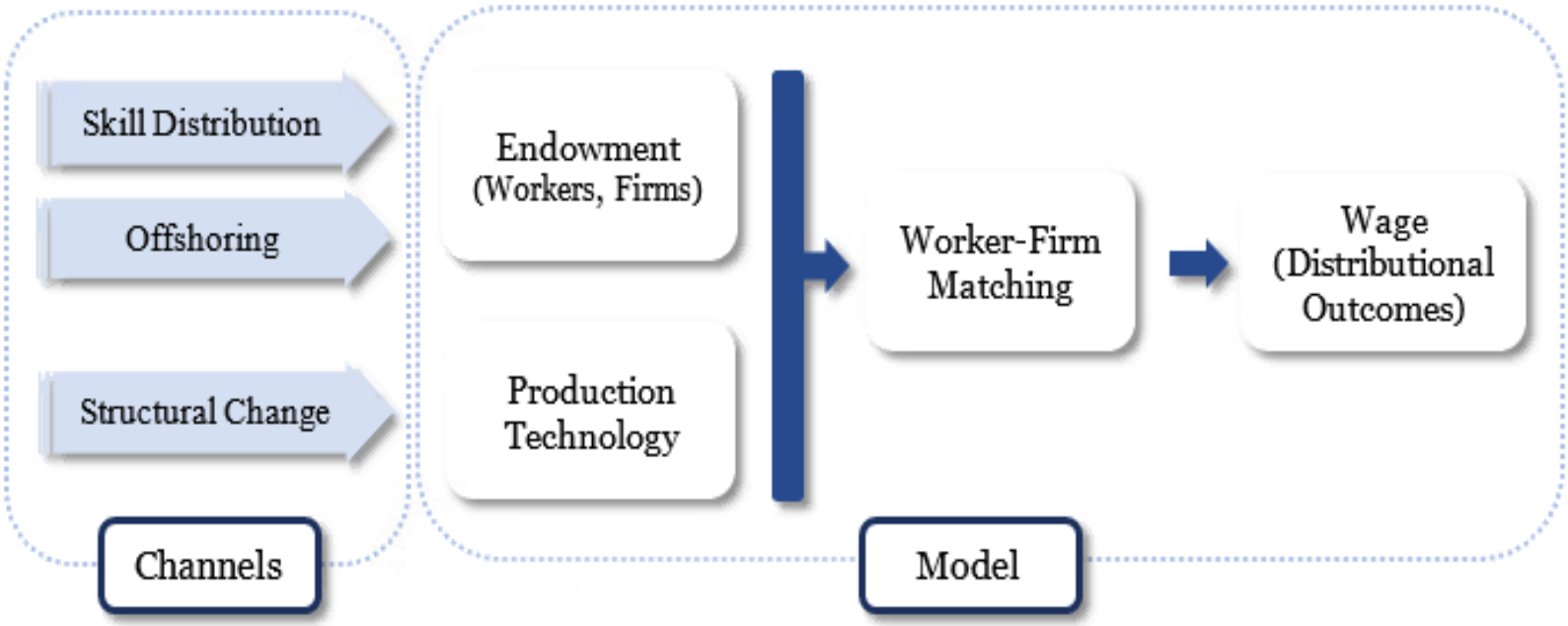
Model Becker-type worker-firm matching model with offshoring

✓ A decrease in offshoring cost increases firms probability of matching with foreign workers mainly for high-productivity firms

✓ Matching between firms and domestic workers changes → Improves the matched quality of domestic workers firms hire

This Paper

Structural Estimation and Counterfactuals



- Within offshorable occupations, the between-firm inequality in wages/skills **increases** with structural change while **decreases** with globalization and trade.

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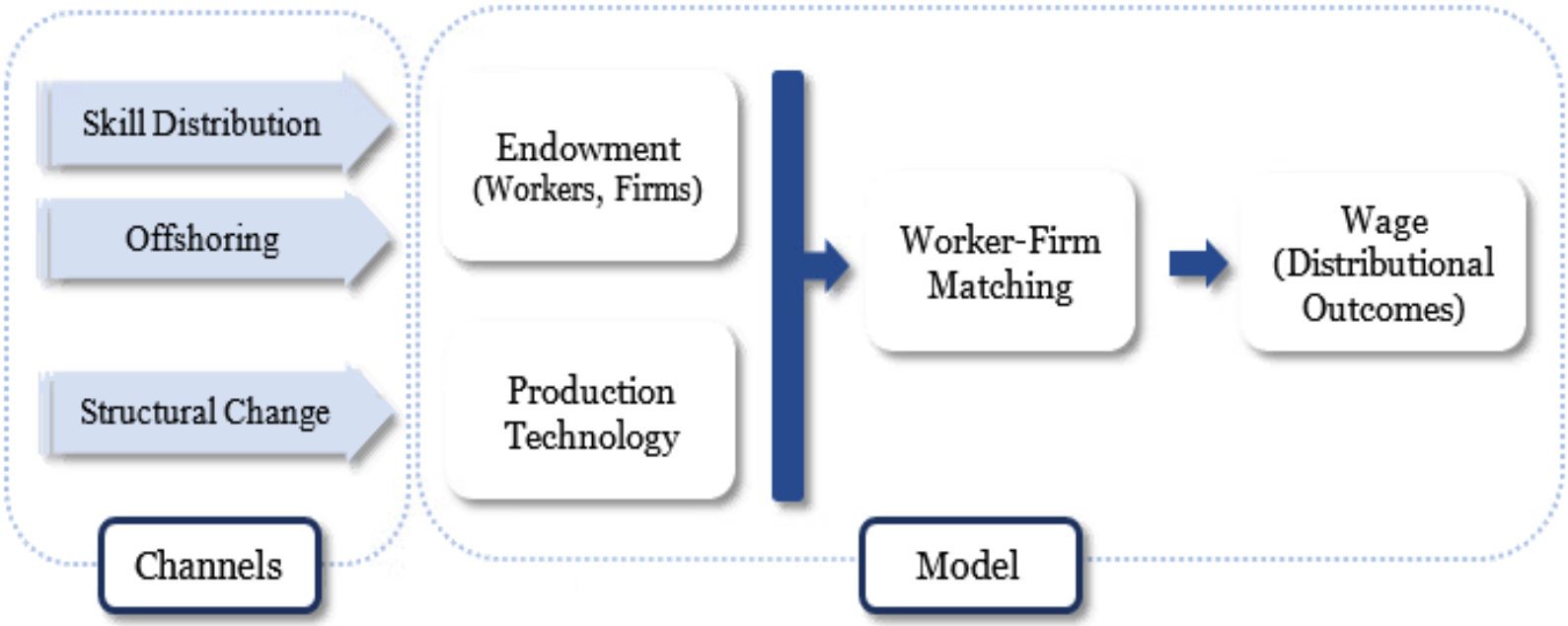
Structural Estimation and Counterfactuals



- Within offshorable occupations, the between-firm inequality in wages/skills **increases** with structural change while **decreases** with globalization and trade.
- Offshoring can lead to beneficial reallocations that reduce wage inequality across firms and skill segregation.

Literature

1. **Matching effects of globalization**

   - Grossman and Maggi (2000); Kremer and Maskin (2003);
     Antràs, Garicano, Rossi-Hansberg (2006); Costinot and Vogel (2010);
     Grossman, Helpman, Kircher (2017); Helpman, Itskhoki, Redding (2010);
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2. **Offshoring and labor markets**

   - Feenstra and Hanson (1990); Grossman and Rossi-Hansberg (2008); Hummels, Jørgensen, Munch, Xiang (2014); Baumgarten, Geishecker, Görg (2013) Ebenstein, Harrison, McMillan, Phillips (2014); Monarch, Park, Sivadasan (2017) Kovak, Oldenski, Sly (2018); Ornaghi et al. (2021); Bernard, Fort, Smeets, Warzynski (2023), Pulito (2024), Colella (2024).

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3. **Segregation and between-firm inequality**

   - Kremer and Maskin (1996); Abowd, Kramarz, Margolis (1999); Card, Heining, Kline (2013); Bagger, Sørensen, Vejlin (2013); Bagger and Lentz (2019); Song, Price, Guvenen, Bloom, Wachter (2019), Handwerker (2023), Håkanson et al. (2024), Lattanzio (2024).

Outline

Data Sources

The Danish data provides the universe of firms and the population of individuals matched through their unique identifiers.

IDA, FIRM The Danish Matched Employer-Employee panel that provides variables on workers' and firms' characteristics (1996-2006).

UHDI International trade data contains firm-level international transactions of goods observed at a triplet of year×country×product (6 digit HS code).

UNCOMTRADE The largest depository of annual cross-country exports and imports data for 160 countries, provided at 6-digit Harmonized System product-level.

Baseline Sample includes firms within the manufacturing sector that operated continuously throughout the period and excludes firms with fewer than 10 employees.

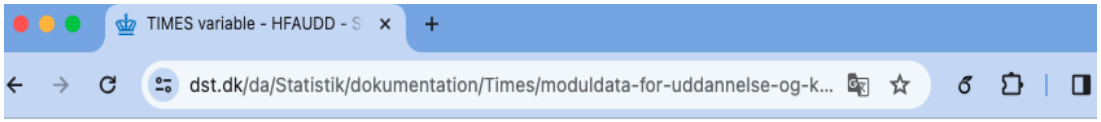
Measurement: Worker Skill

Key Variables to Construct Skills

- *hfaudd* (highest obtained education); *erhaudd* (highest completed training)

→ 2449 different types of education degrees and job training records

→ We match with the most relevant occupation in O-net and use three groups of job descriptors

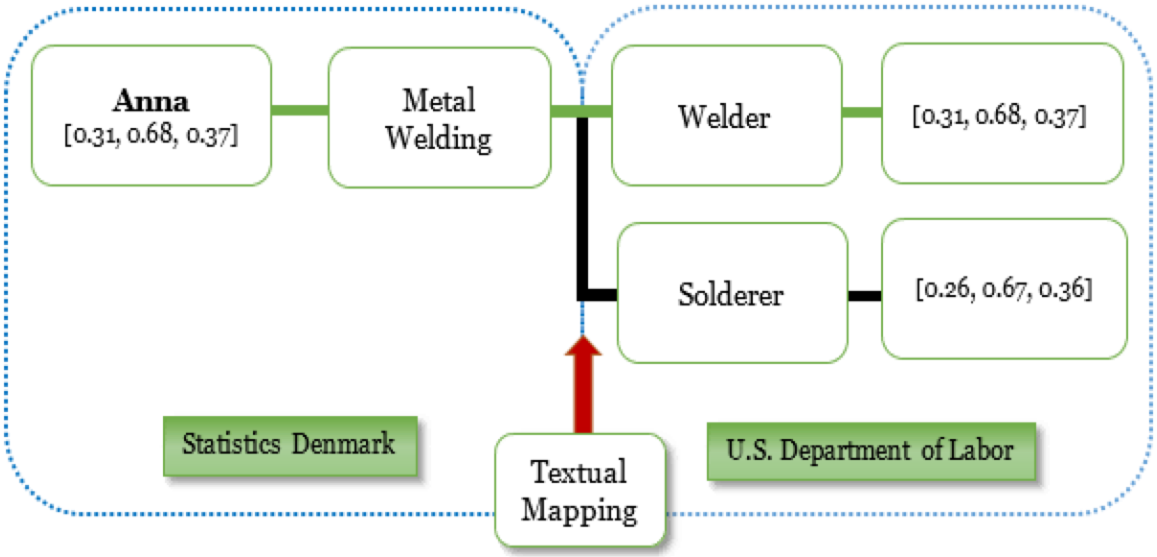


3252	Glazier
3253	Plastic maker specializing in thermoplastics
3254	Plastic maker specializing in thermosetting plastics
3255	Specialist in plastic production
3257	Flight electronics
3258	Blacksmith (maritime)
3259	Production manager
3261	Energy and Environment, diploma programme
3267	Truck driver with crane
3273	Classical philology, cand.mag.
3274	Laboratory technology, prof.bach.
3275	B1 aircraft technician, mechanics
3276	Agricultural economics, prof.bach.
3277	E-commerce, prof.bach.

Measurement: Worker Skill

✓ We convert text information on education and training to vectors of skills

Example



▸ O*NET Code Connector

Measurement: Worker Skill

✓ Our skill measures importantly explain variations in wages

Table: Wage Regression with Skill Measures

	(1)	(2)	(3)	(4)	(5)
Education	0.160***	0.141***	0.141***	0.0873***	0.0870***
	(0.000271)	(0.000327)	(0.000327)	(0.000350)	(0.000354)
Experience	0.0317***	0.0326***	0.0313***	0.0338***	0.0339***
	(0.000184)	(0.000186)	(0.000193)	(0.000182)	(0.000183)
Experience Squared	-0.000579***	-0.000602***	-0.000543***	-0.000758***	-0.000762***
	(6.09e-06)	(6.13e-06)	(6.57e-06)	(6.07e-06)	(6.12e-06)
Cognitive Skills		0.278***	0.278***	0.133***	0.153***
		(0.00318)	(0.00317)	(0.00323)	(0.00321)
Manual Skills		0.107***	0.108***	0.00292*	0.00670***
		(0.00165)	(0.00164)	(0.00176)	(0.00171)
Interpersonal Skills		0.366***	0.363***	0.180***	0.177***
		(0.00292)	(0.00292)	(0.00290)	(0.00286)
Year FE	-	-	✓	✓	✓
Occupation FE	-	-	-	✓	✓
Observations	1,396,738	1,383,726	1,383,726	1,368,481	1,348,073
R-squared	0.318	0.329	0.330	0.475	0.477

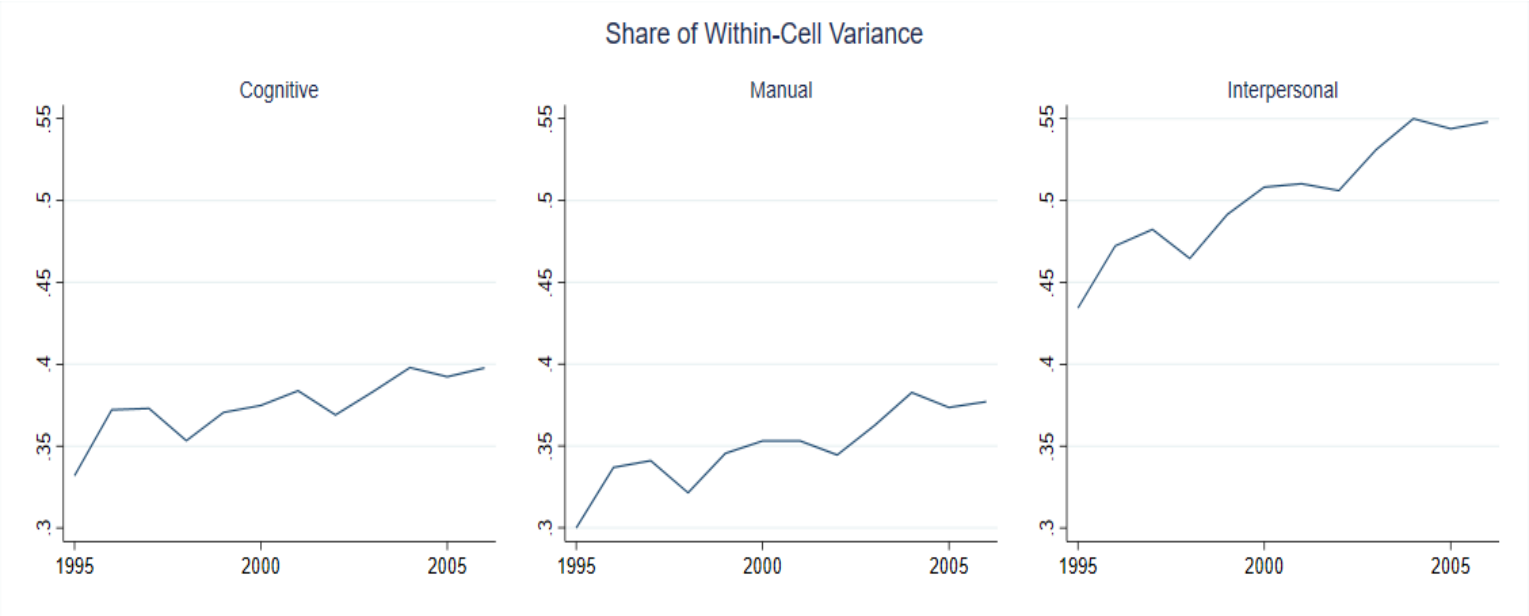
Outline

Stylized Facts

Fact 1. Within-cell variance of skill is high, and increases over time

$$\frac{1}{N_t}\sum_l\sum_{i\in l}(s_{it}-\bar{s}_t)^2=\frac{1}{N_t}\sum_l\sum_{i\in l}(s_{it}-\bar{s}_{lt})^2+\frac{1}{N_t}\sum_l\sum_{i\in l}(\bar{s}_{lt}-\bar{s}_t)^2 \tag{1}$$

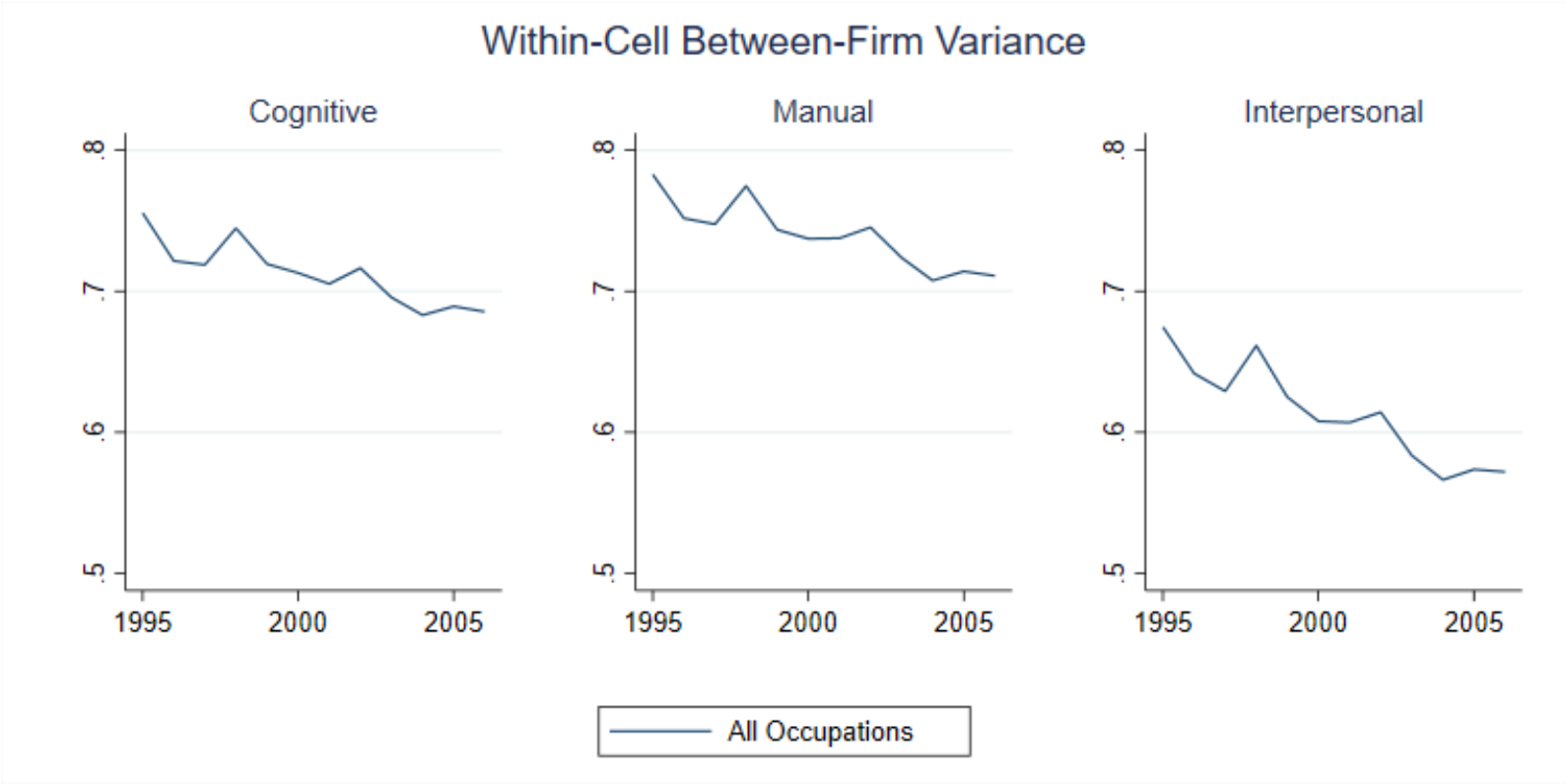
where cell (l) is defined at the industry-occupation-education level



Stylized Facts

Fact 2. The between-firm share in explaining the within-cell variance of skill decreases over time.

$$s_{it} = \psi_{jlt} + \omega_{it}$$
$$var(s_{it}) = var(\hat{\psi}_{jlt}) + var(\hat{\omega}_{it}) \tag{2}$$



▸ Occupational Offshorability

Stylized Facts

Fact 2. The between-firm share in explaining the within-cell variance of skill decreases over time.Especially in high-offshorable occupations.

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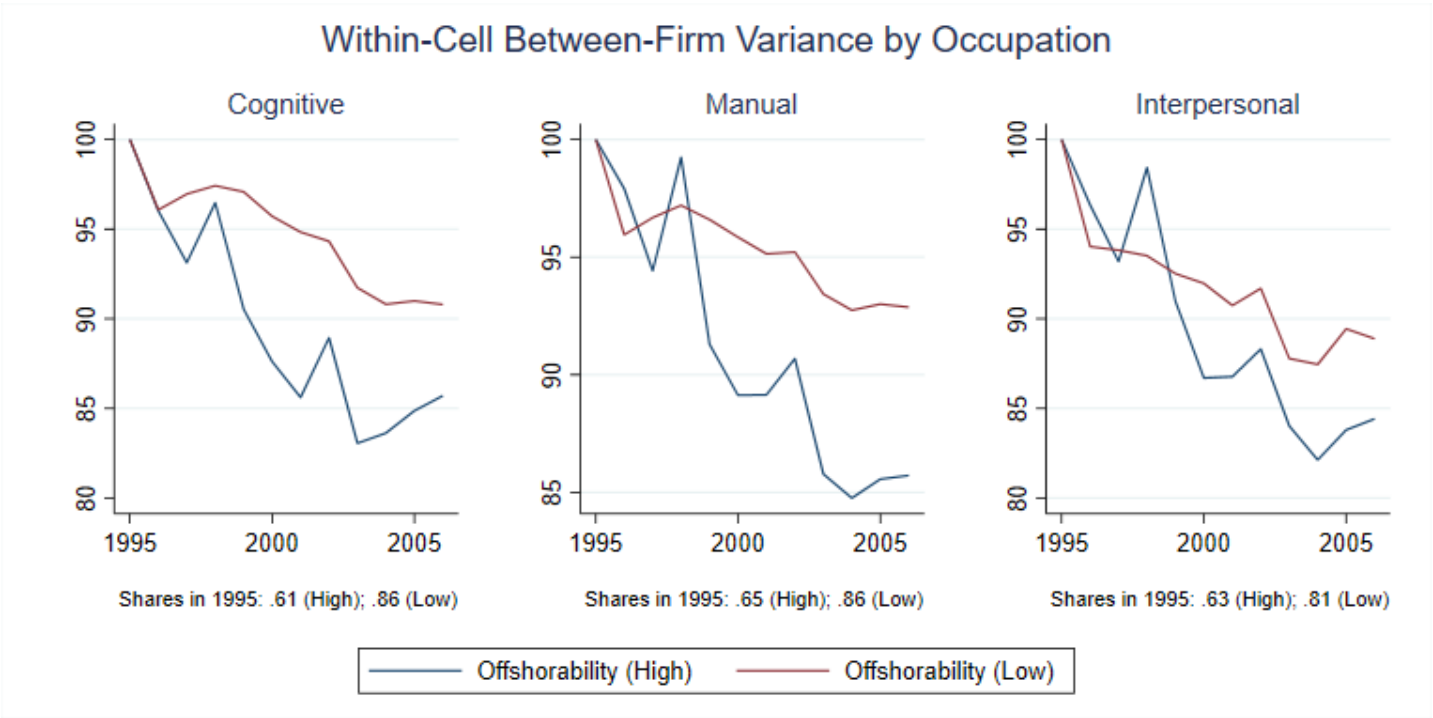

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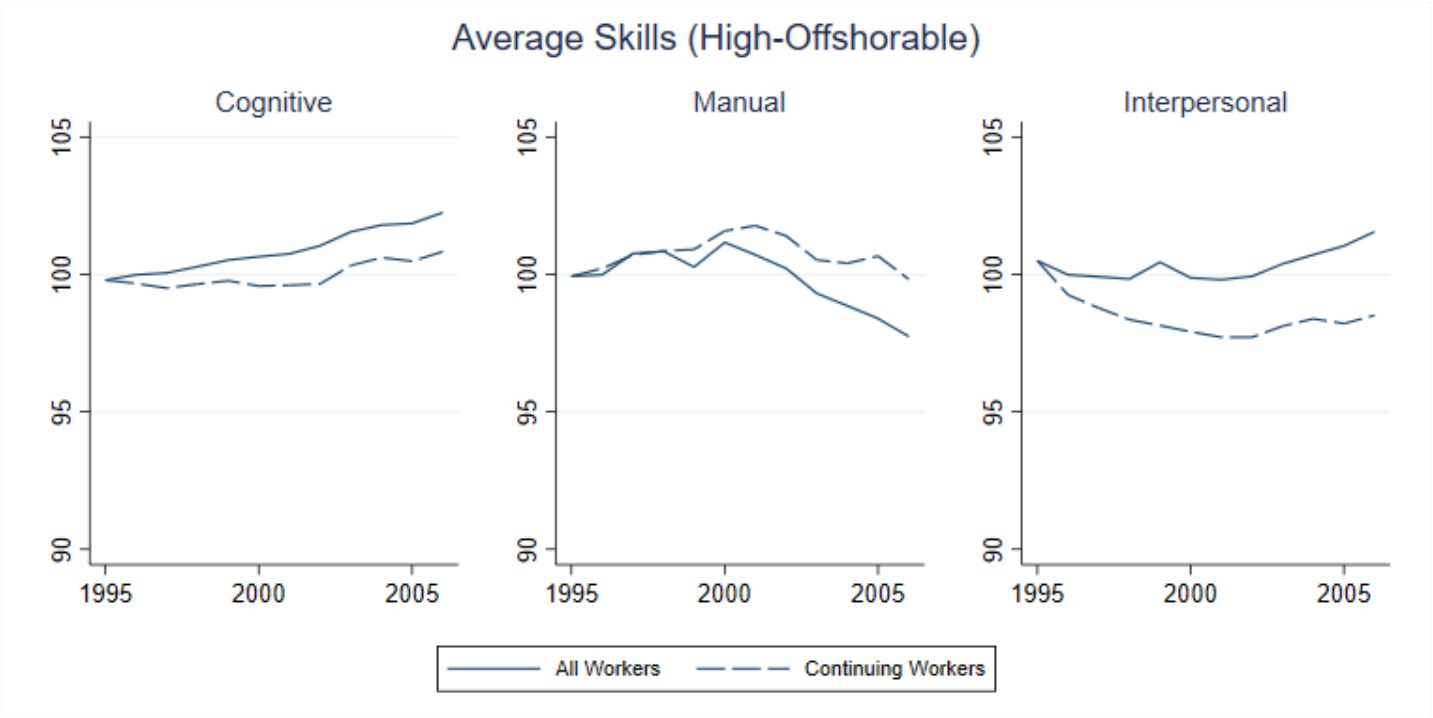
Stylized Facts

Fact 3. For high-offshorable occupations, the within-firm average of cognitive and interpersonal skills increases while that of manual skills decreases—the contribution of new matches increases over time.



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Regression Analysis

✓ *Stylized Facts*: Offshoring ⇒ Average of firm skills ↑, Variance of firm skills ↓

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Offshoring Exposure from China

- Total imported goods at firm level, excluding raw materials
- Focus on products that firms both import and export
  (Olney and Pozzoli, 2021; Bernard et al. 2023)
- Firm-level offshoring aggregated at 6-digit industries

Regression Analysis

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Identification (Hummels et al, 2014 AER)

We construct a Bartik-type instrumental variable of world export supply,

$$I_{kt} = \sum_{h} s_{hk0} \times \text{WES}_{ht} \tag{3}$$

- Product-level export supply from China to the world excluding Denmark in time t
- Initial product shares imported by each industry in the pre-sample period

▸ Validity of Instruments

Regression Analysis

✓ Offshoring improves the average skills of firms in high-offshorable occupations

	IV (Dependent Variable: Average Cognitive Skills × 100)			
	All	By Occupational Offshorability		
		Low (H-Skill)	**Low (M/L-Skill)**	**High**
	(1)	**(2)**	**(3)**	**(4)**
Offshoring (China)	0.0259	0.2150	0.1412**	0.1491***
	(0.0476)	(0.1197)	(0.0702)	(0.0544)
Sector by Year FE	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓
Mean Y	51.82	58.64	55.91	49.44
First Stage F-stat	848.33	566.03	749.71	824.05
AR First Stage F-stat	0.34	9.11	5	8.81
N	35,960	22,845	28,534	34,058

Regression Analysis

✓ Offshoring improves the average skills of firms in High-offshorable occupations
- More pronounced effects on low-type firms
- Small adjustments through skill updates

	IV (Dependent Variable: Average Cognitive Skills × 100, High-offshorable)					
	All Workers			All Workers (Invariant Skills)		
	All	By Firm Productivity		**All**	By Firm Productivity	
		Low	**High**		**Low**	**High**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Offshoring (China)	0.1491***	0.2736***	-0.1732	0.1587***	0.2454***	-0.1356
	(0.0544)	(0.0623)	(0.1305)	(0.0520)	(0.0595)	(0.1256)
Sector by Year FE	✓	✓	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓	✓	✓
Mean Y	49.44	48.81	50.06	49.37	48.75	49.98
First Stage F-stat	824.05	687.51	138.85	817.78	685.32	134.16
AR First Stage F-stat	8.87	23.80	2.19	11.01	20.87	1.45
N	34,058	16,816	16,816	34,097	16,827	16,852

Regression Analysis

✓ Offshoring improves the average skills of firms in High-offshorable occupations
- More pronounced effects on low-type firms
- Small adjustments through skill updates
- Compositional changes in in-house workers are important

	IV (Dependent Variable: Average Cognitive Skills × 100, High-offshorable)					
	All Workers			Continuing Workers (Invariant Skills)		
	All	By Firm Productivity		**All**	By Firm Productivity	
		Low	**High**		**Low**	**High**
	(1)	**(2)**	**(3)**	**(7)**	**(8)**	**(9)**
Offshoring (China)	0.1491***	0.2736***	-0.1732	0.0855*	0.1030**	0.1619
	(0.0544)	(0.0623)	(0.1305)	(0.0440)	(0.0464)	(0.1221)
Sector by Year FE	✓	✓	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓	✓	✓
Mean Y	49.44	48.81	50.06	49.09	48.58	49.58
First Stage F-stat	824.05	687.51	138.85	731.37	682.05	96.78
AR First Stage F-stat	8.87	23.80	2.19	4.49	6.01	2.22
N	34,058	16,816	16,816	28,915	14,119	14,395

Regression Analysis

Robustness Exercises

- Alternative Definitions of Firm Types: Sales per capital stock; Total factor productivity ▸ Alternate
- Alternative Measures of Offshoring: Low-wage countries (Bernard et al. 2006) and 4-digit industry. ▸ Low-wage
- Time-varying Firm-level Controls: Firms' sales, size, and trade status ▸ Firm Controls
- Instrument for Exports (Hummels et al. 2014) ▸ IV Exports
- Weighted Regressions ▸ Weighted
- Exclude Copenhagen and Environs ▸ Exc. Copenhagen
- By Labor-Intensive Industries, unbalanced sample and all firms (incl. fewer than 10 employees) ▸ L-Intensive Industries

Outline

Baseline Economy

Matching Model à la Dupuy and Galichon (2014)

$\Rightarrow$ Becker (1973) + Continuous Observables + Unobservable Preferences

Baseline Economy

Matching Model à la Dupuy and Galichon (2014)

✓ An economy endowed with a continuum of workers and firms

- Worker's skills, $x \in \mathcal{X} \subseteq \mathbb{R}^m$, $\overline{f}(x)$; Firm's characteristics, $y \in \mathcal{Y} \subseteq \mathbb{R}^n$, $\overline{g}(y)$

Baseline Economy

Matching Model à la Dupuy and Galichon (2014)

✓ Output is produced through a worker-firm match

$$q(x, y) = x' \Phi y + C \tag{4}$$

- $\Phi_{i,j} > (<) 0 \Leftrightarrow$ PAM (NAM) between worker's skill x_i and firm's characteristic y_j

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$$q(x, y) = x' \Phi y + C \tag{4}$$

- $\Phi_{i,j} > (<) 0 \Leftrightarrow$ PAM (NAM) between worker's skill x_i and firm's characteristic y_j

✓ Workers search for firms (i.e., *acquaintances*) and forms idiosyncratic preferences

- Worker i has a set of acquaintances $S^i = \{y_1^i, y_2^i, \cdots\}$
- Each y_k^i is associated with an i.i.d. preference shock ϵ_k^i
- (y_k^i, ϵ_k^i) follows a Poisson point process with density $\exp(\nu_x) \cdot \exp(-\epsilon) d\epsilon dy$
- ν_x governs the matching intensities at each (y, e)
- Symmetric process for firms

Baseline Economy

✓ The utility maximization problem of a worker i with x^i,

$$U^i = \max\left[w_0 + \lambda_x \epsilon_0^i, \quad \max_{y_k^i \in S^i} \left(w(x^i, y_k^i) + \lambda_x \epsilon_k^i\right)\right] \tag{5}$$

- w_0 is the outside option; ϵ_0^i is the *i.i.d.* preference shock to be unmatched
- λ_x governs the variance of the idiosyncratic preferences

Baseline Economy

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- w_0 is the outside option; ϵ_0^i is the *i.i.d.* preference shock to be unmatched
- λ_x governs the variance of the idiosyncratic preferences

✓ The profit maximization of a firm j with y^j,

$$V^j = \max\left[r_0 + \lambda_y \epsilon_0^j, \quad \max_{x_k^j \in S^j} \left(r(x_k^j, y^j) + \lambda_y \epsilon_k^j\right)\right] \tag{6}$$

- r_0 is the outside option; ϵ_0^j is the *i.i.d.* preference shock to be unmatched
- λ_y governs the variance of the idiosyncratic preferences

Baseline Economy

✓ Solving the maximization problems

⇔ Poisson Stochastic Process → Continuous Logit Model

Workers

$$\pi(y|x) = \frac{\pi(x,y)}{f(x)} = \frac{\exp\frac{w(x,y)}{\lambda_x}}{\int \exp\frac{w(x,y)}{\lambda_x} dy}$$

$$f_0(x) = \frac{\exp\frac{w_0(x)-\alpha_x}{\lambda_x}}{\exp\frac{w_0(x)-\alpha_x}{\lambda_x} + \int \exp\frac{w(x,y)}{\lambda_x} dy} \overline{f}(x), \qquad f(x) = \int \pi(x,y)dy = \overline{f}(x) - f_0(x)$$

Firms

$$\pi(x|y) = \frac{\pi(x,y)}{g(y)} = \frac{\exp\frac{r(x,y)}{\lambda_y}}{\int \exp\frac{r(x,y)}{\lambda_y} dx}$$

$$g_0(y) = \frac{\exp\frac{r_0(x)-\alpha_y}{\lambda_y}}{\exp\frac{r_0(x)-\alpha_y}{\lambda_y} + \int \exp\frac{r(x,y)}{\lambda_y} dy} \overline{g}(y), \qquad g(y) = \int \pi(x,y)dx = \overline{g}(y) - g_0(y)$$

Global Economy

Globalization

$\Leftrightarrow$ Access to foreign workers *increases* due to technological progress or changes in economic institutions

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$\Leftrightarrow$ Access to foreign workers *increases* due to technological progress or changes in economic institutions

✓ Foreign economy endowed with a continuum of workers

- Worker's skills, $x \in \mathcal{X} \subseteq \mathbb{R}^m$, $\overline{f}^*(x)$

✓ Output is produced through a worker-firm match

$$q^*(x, y) = x' \Phi^* y + C^* \tag{7}$$

- $\Phi^* = \Phi$
- $C - C^*$ captures the cost of offshoring

✓ Same assumptions on the acquaintances for Foreign workers

- $(y_k^{i*}, \epsilon_k^{i*})$ follows a Poisson point process with density $\exp(\nu_x^*) \cdot \exp(-\epsilon) d\epsilon dy$
- ν_x^* governs the rate of finding matches at each (y, e)

Global Economy

✓ The utility maximization problem of a worker i with x^i,

$$U^i = \max\left[w_0 + \lambda_x \epsilon_0^i, \quad \max_{y_k^i \in S^i} \left(w(x^i, y_k^i) + \lambda_x \epsilon_k^i\right)\right] \tag{8}$$

Global Economy

✓ The utility maximization problem of a Foreign worker i^* with x^{i*},

$$U^{i*} = \max\left[w_0^*(x^{i*}) + \lambda_x \epsilon_0^{i*}, \max_{y_k^{i*} \in S^{i*}} \left(w^*(x^{i*}, y_k^{i*}) + \lambda_x \epsilon_k^{i*}\right)\right] \tag{8}$$

- w_0^* is the outside option; ϵ_0^{i*} is the *i.i.d.* preference shock to be unmatched
- λ_x governs the variance of the idiosyncratic preferences

Global Economy

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$$U^{i*} = \max\left[w_0^*(x^{i*}) + \lambda_x \epsilon_0^{i*}, \max_{y_k^{i*} \in S^{i*}} \left(w^*(x^{i*}, y_k^{i*}) + \lambda_x \epsilon_k^{i*}\right)\right] \tag{8}$$

- w_0^* is the outside option; ϵ_0^{i*} is the *i.i.d.* preference shock to be unmatched
- λ_x governs the variance of the idiosyncratic preferences

✓ The profit maximization of a firm j with y^j,

$$V^j = \max\left[r_0 + \lambda_y \epsilon_0^j, \max_{x_k^j \in S^j} \left(r(x_k^j, y^j) + \lambda_y \epsilon_k^j\right), \max_{x_k^{*j} \in S^{*j}} \left(r(x_k^{*j}, y^j) + \lambda_y \epsilon_k^{*j}\right)\right] \tag{9}$$

- r_0 is the outside option; ϵ_0^j is the *i.i.d.* preference shock to be unmatched
- λ_y governs the variance of the idiosyncratic preferences

Global Economy

Equilibrium Properties of Global Economy

$$\begin{aligned}\lambda \log \frac{\pi^*(x,y)}{\pi(x,y)} &= \big(q^*(x,y) - a^*(x) - b^*(y)\big) - \big(q(x,y) - a(x) - b(y)\big) \\ &= \underbrace{\big(q^*(x,y) - q(x,y)\big)}_{-c_F} - \underbrace{\big(a^*(x) - a(x)\big)}_{+\widetilde{a}(x)} - \underbrace{\big(b^*(y) - b(y)\big)}_{-(\nu_y^* - \nu_y)}\end{aligned} \tag{10}$$

✓ Matching with foreign workers relative to domestic workers increases when,

1. Cost of offshoring (c_F) $\downarrow$
2. Matching intensities with foreign relative to domestic workers ($\nu_y^* - \nu_y$) $\uparrow$

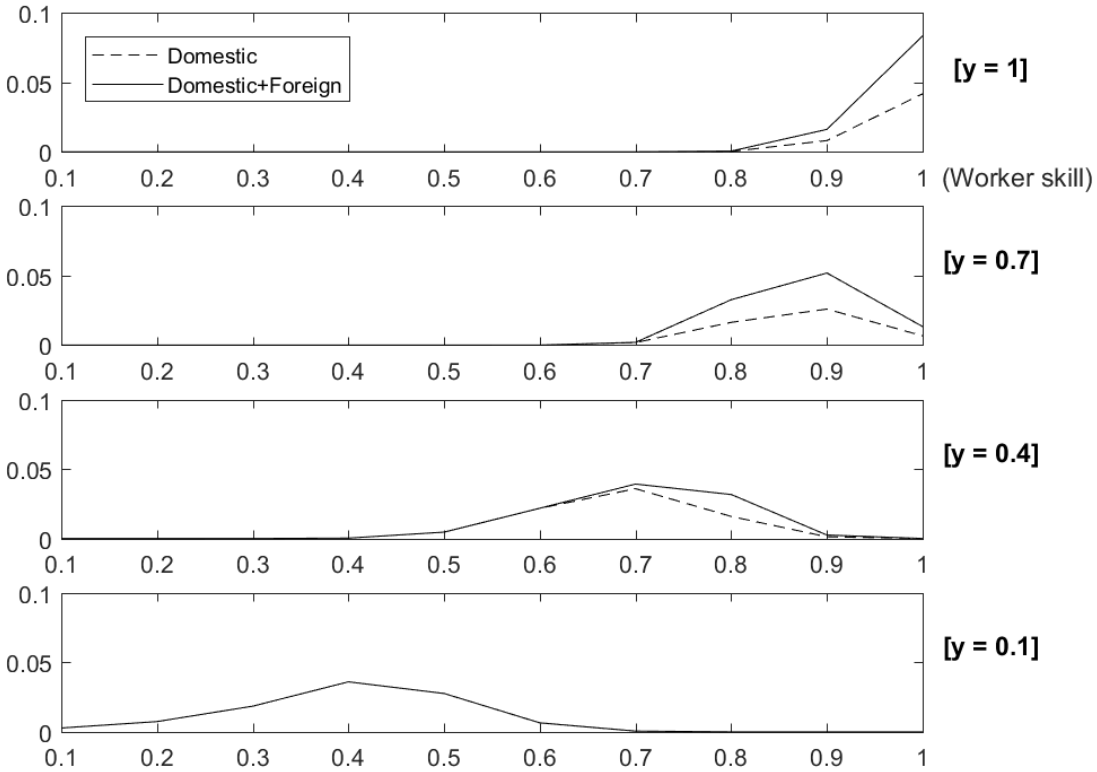
✓ If $\Phi > 0$ (i.e., PAM), then matching with foreign workers relative to domestic workers are more likely to occur for firms with high y ($\widetilde{a}'(x) < 0$)

▸ Estimation

Global Economy

Illustration of Equilibrium

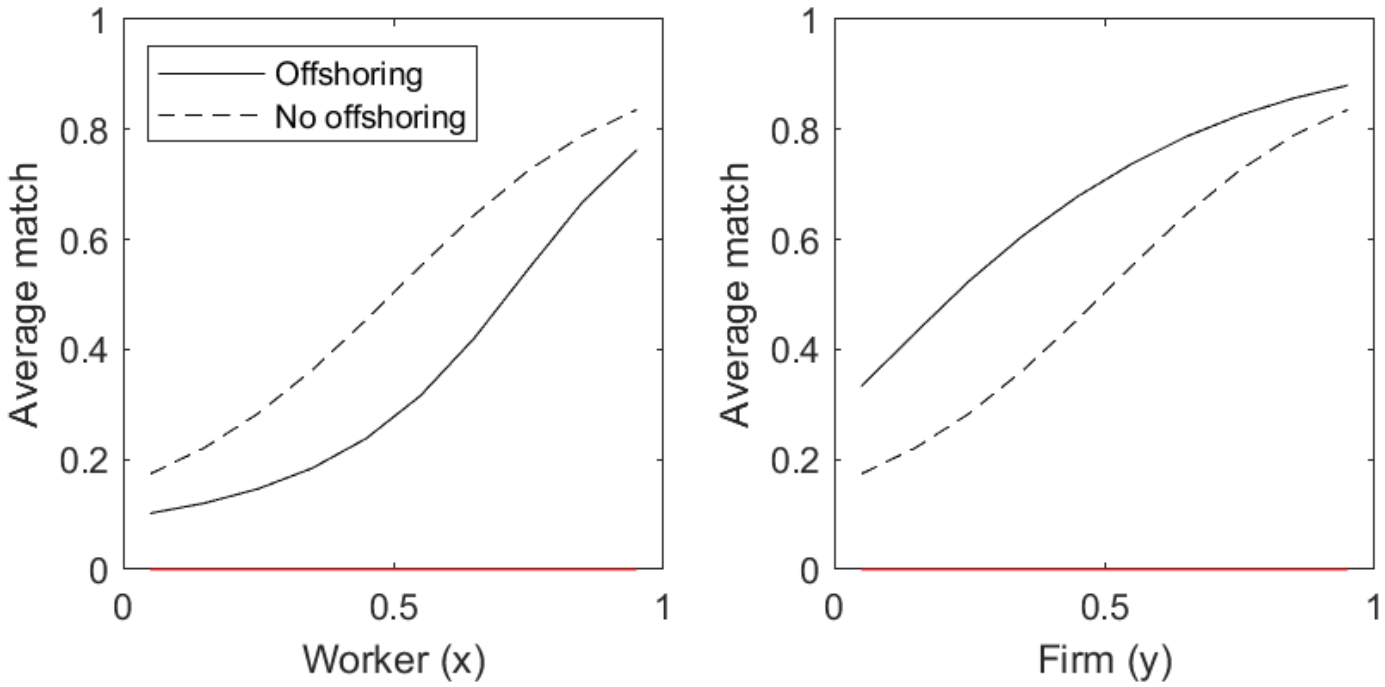
✓ Probability of offshoring is higher for high-type firms



Global Economy

Illustration of Equilibrium

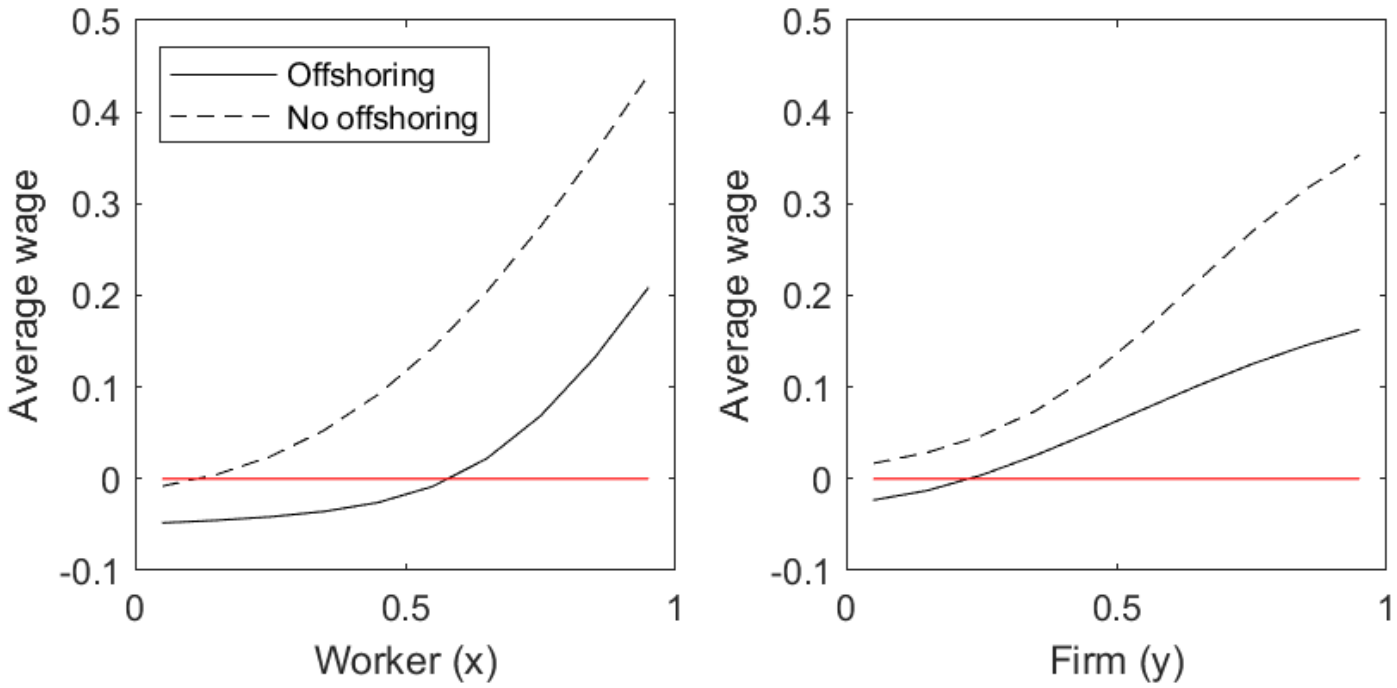
✓ Average quality of matching improves with offshoring



Global Economy

Illustration of Equilibrium

✓ Average wage falls with offshoring



Outline

Structural Estimation with Offshoring

Identifying Assumption: Unobserved Offshored Matches

If firms are indifferent between offshoring and domestic hires, the optimally chosen workers from Home and Foreign are equally talented.

Assumption

$$\frac{\text{Intermediate and Final Good Purchases Abroad}}{\text{Value Added}} = \frac{\text{Number of Offshored Workers}}{\text{Number of Domestic Workers}}$$

Use Equation (10) to distribute the constructed mass across the distribution of workers ▸ Key Eqm Properties

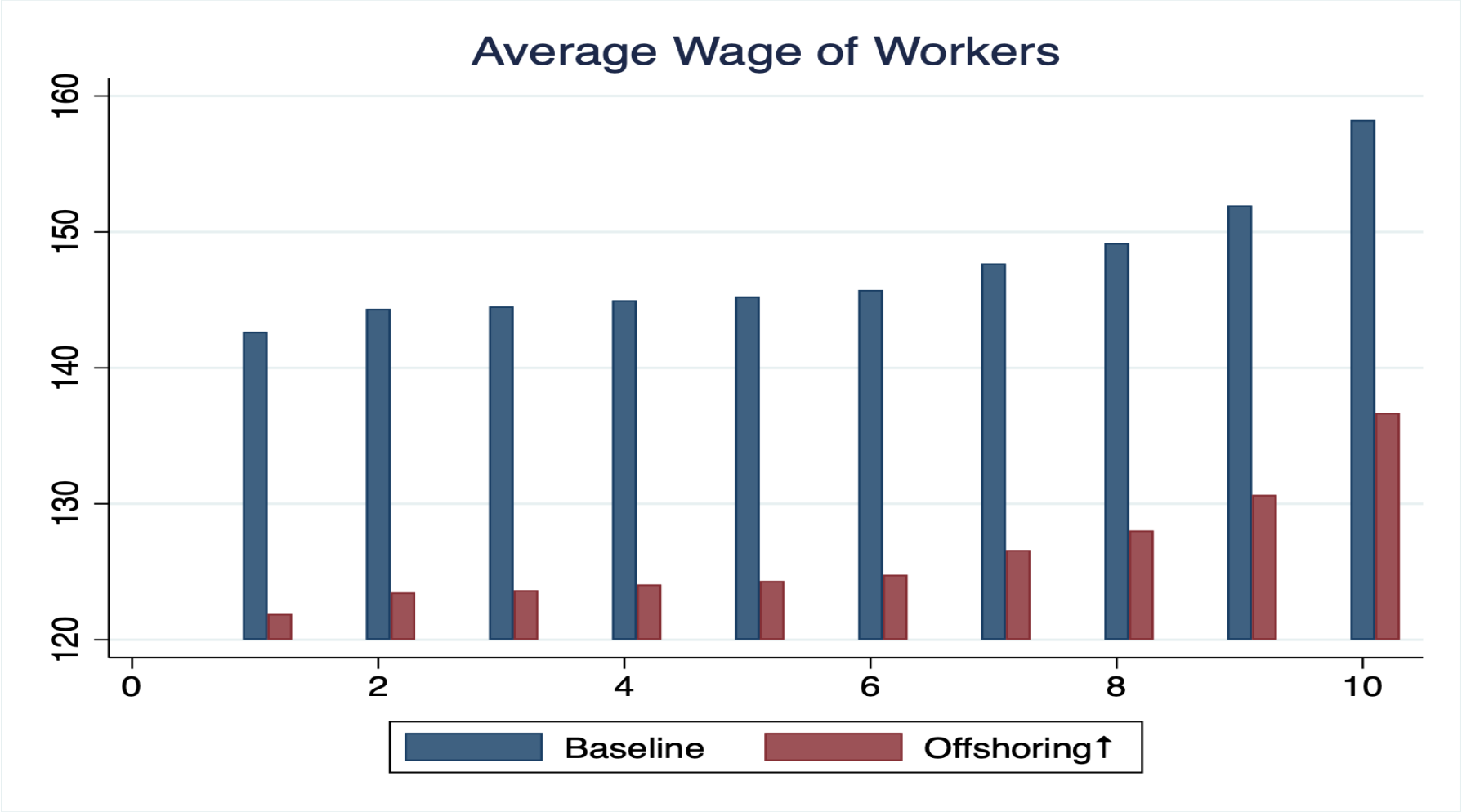
Calibrated Parameters

Parameters	1996	2006	Note
r_0	0	0	outside option for domestic firms, authors' assumption
w_0	40.538	45.276	unemployment insurance benefit (hourly in DKK), Statistics Denmark
w_0^*	17.945	25.825	average wage of the agricultural sector in China (hourly in DKK), feenstra2007china
$E(w^*)$	28.672	56.513	average wage of the manufacturing sector in China (hourly in DKK), [?]
$\mathbb{W}/\mathbb{Y}$	0.5371	0.6786	aggregate share of wage-bill in value-added, author's calculation using Danish data
$\lvert f_0\rvert/\lvert\overline{f}\rvert$	0.0633	0.0391	unemployment rate, IMF International Financial Statistics (IFS)
$\lvert\overline{f^*}\rvert$	0.6325	0.6325	mass of potential matches to Danish firms in China (ILO, Fu and Wu (2013), Danish data)
$\lvert f^*\rvert/\lvert f\rvert$	0.0005	0.0155	rate of offshoring, author's calculation using Danish data
$\lvert\overline{f}\rvert$	1	1	total mass of domestic workers, normalization
$\lvert\overline{g}\rvert$	$\lvert\overline{f}\rvert(1+\frac{\lvert f^*\rvert}{\lvert f\rvert})$	$\lvert\overline{f}\rvert(1+\frac{\lvert f^*\rvert}{\lvert f\rvert})$	total mass of domestic firms

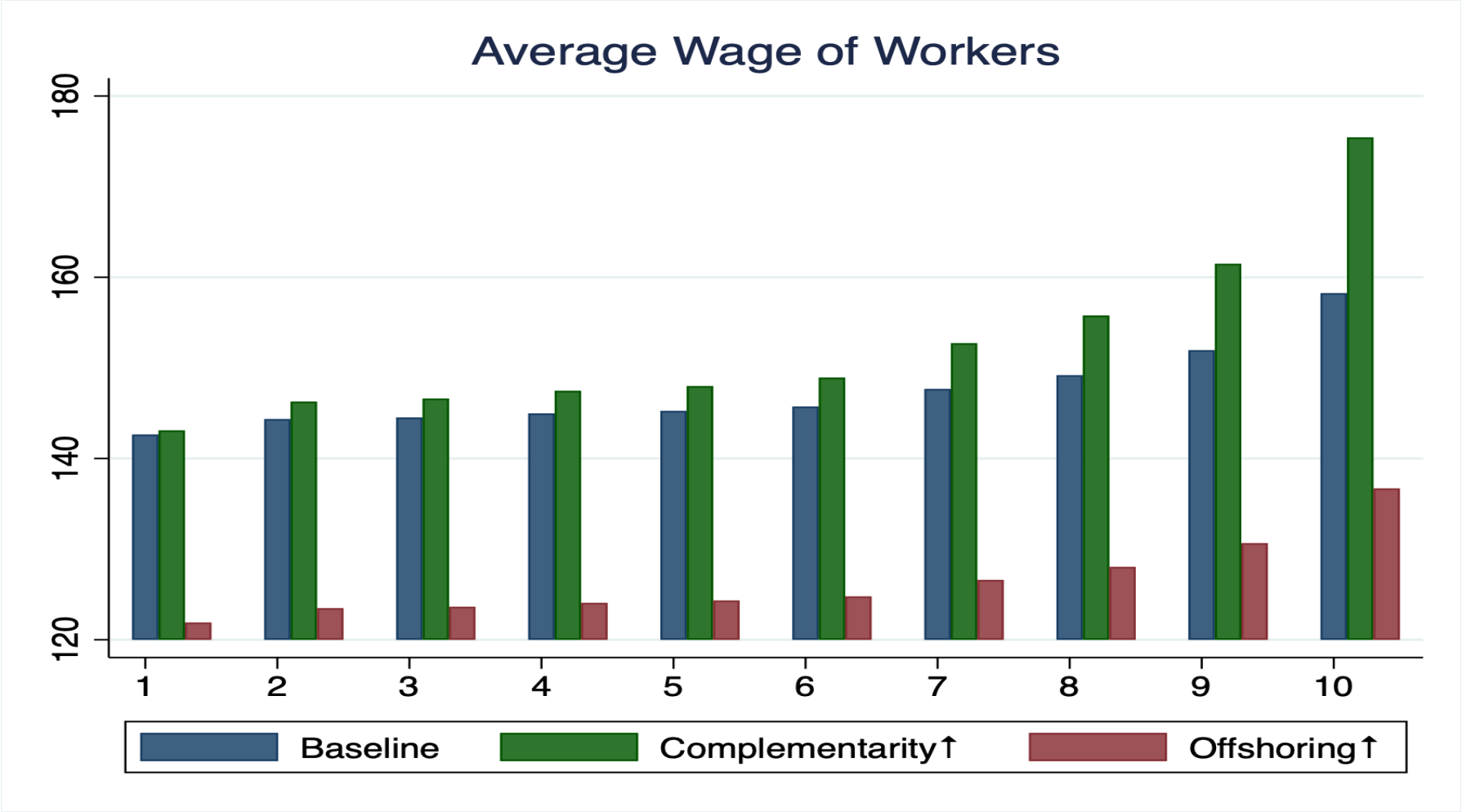
Estimation Results

	Parameter	1996	2006
Φ	matching technology	75.38 (69.16, 79.58)	75.55 (70.37, 79.07)
λ	variance of idiosyncratic preferences ($\lambda_x + \lambda_y$)	108.78 (80.49, 170.42)	37.56 (33.55, 41.69)
C	constant term in the matched surplus for domestic matches	240.66 (240.01, 241.30)	207.90 (207.35, 208.71)
C^*	constant term in the matched surplus for foreign matches	138.73 (137.75, 139.46)	119.94 (119.38, 120.62)
ν_x	matching intensity for domestic workers towards domestic firms	-1.32 (-1.92, -.7)	-4.51 (-5.15, -3.98)
ν_y	matching intensity for domestic firms towards domestic workers	-1.73 (-2.47, -.96)	-2.79 (-3.23, -2.43)
ν_x^*	matching intensity for foreign workers towards domestic firms	-9.56 (-9.70, -9.43)	-7.57 (-7.78, -7.37)
ν_y^*	matching intensity for domestic firms towards foreign workers	-9.22 (-10.00, -8.44)	-6.99 (-7.44, -6.59)

Changes in Between-Firm Wage Inequality: Offshorable Occupations



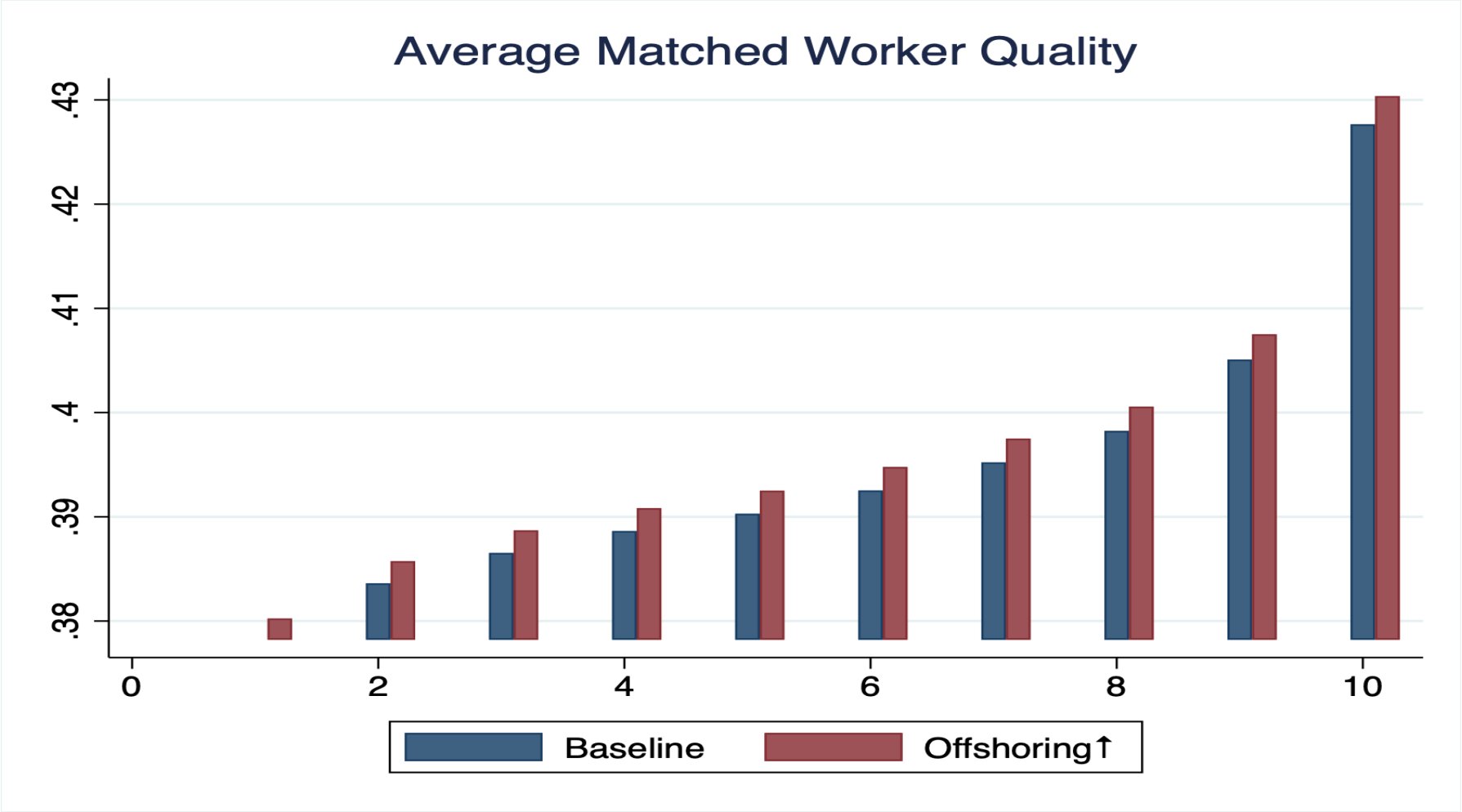
Changes in Between-Firm Wage Inequality: Offshorable Occupations



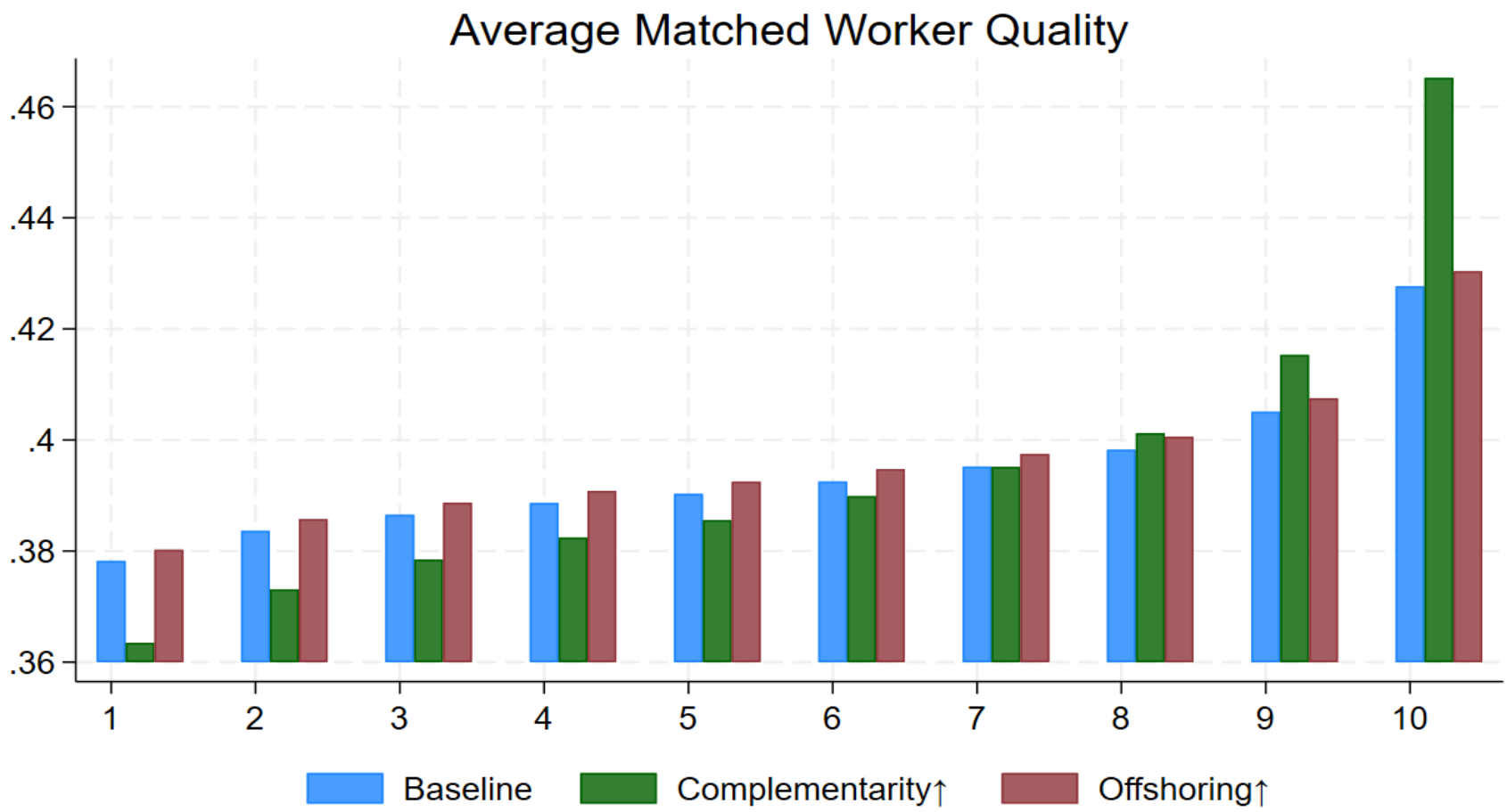
Counterfactuals: Wage Inequality

	Baseline (2006)	Counterfactuals					
		$c_F = 0$	$\Phi \uparrow$	$\nu_x \uparrow$	$\nu_y \uparrow$	$\nu_x^* \uparrow$	$\nu_y^* \uparrow$
$E(wage)$	147.42	130.81	151.72	139.18	157.96	145.46	145.46
$SD(wage)$	4.63	4.47	9.58	4.67	4.67	4.61	4.61
$E(wage\|y)_{10-90}$	1.33	1.01	5.95	1.11	1.11	1.27	1.27
$E(wage\|x)_{10-90}$	15.73	15.03	32.51	15.90	15.90	15.66	15.66

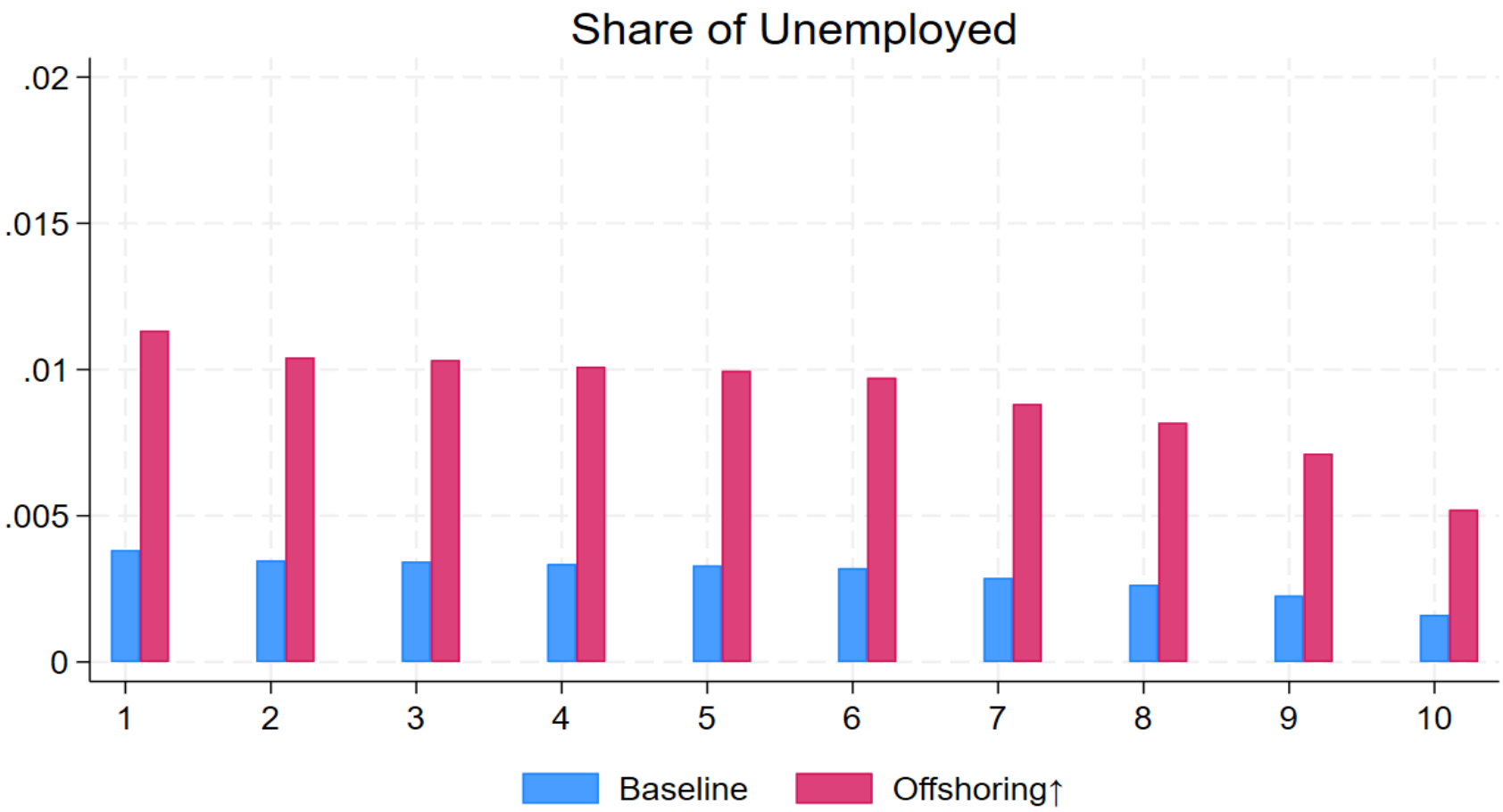
Changes in Firms' Matching: Offshorable Occupations



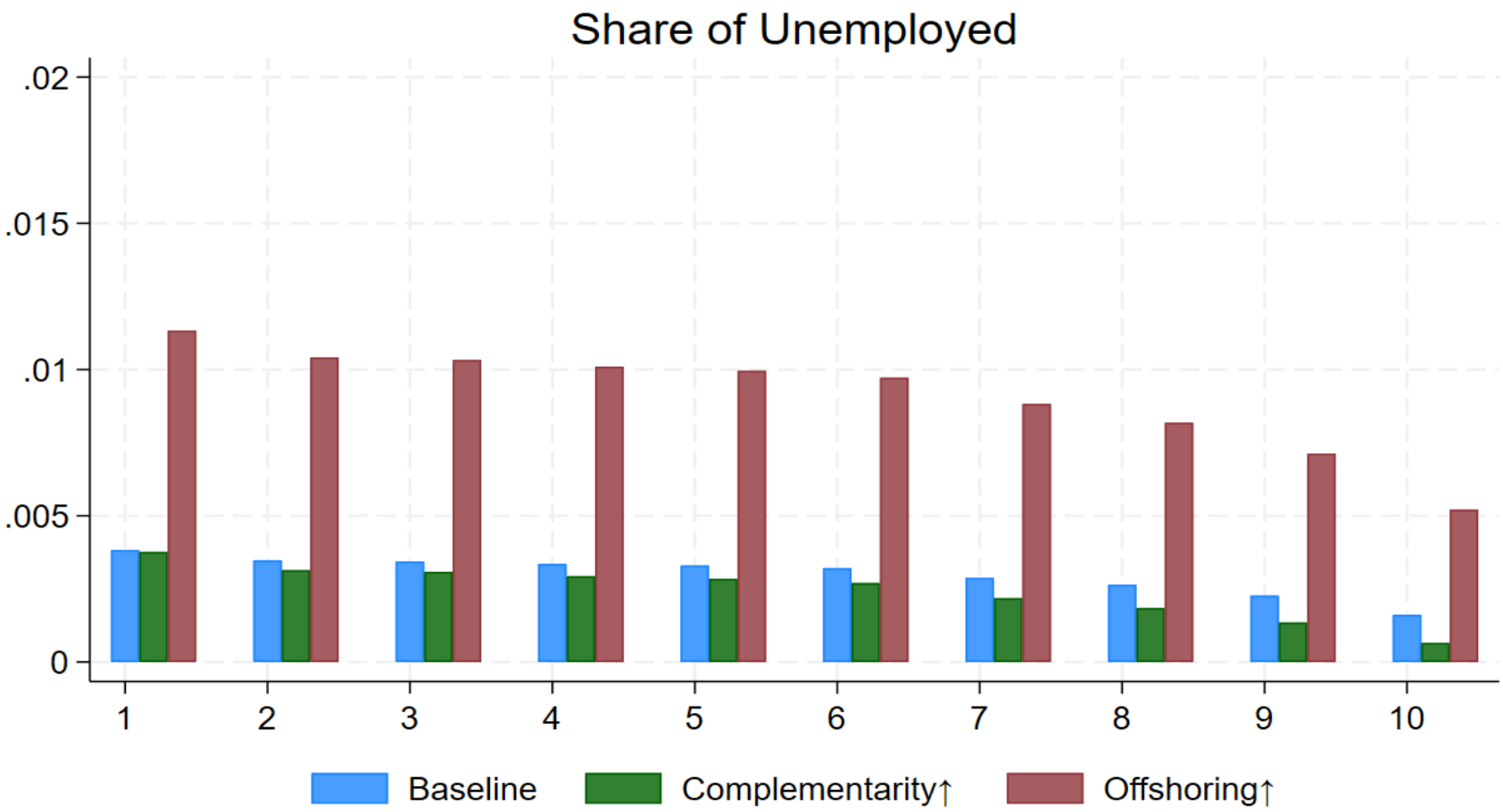
Changes in Firms' Matching: Offshorable Occupations



Changes in Unemployment: Offshorable Occupations



Changes in Unemployment: Offshorable Occupations



Outline

Concluding Remarks

Using a novel skill data set merged with the Danish matched data,

We empirically establish the causal effects of offshoring on firm's demand for skills within high-offshorable occupations

- firm's average quality of worker skills improves
- the improvement mainly occurs within low-productivity firms

We propose a worker-firm matching framework that supports the empirical findings

Through a structural estimation of the model, we find that globalization reduces the **between-firm wage/skill inequality gap** within offshorable occupations.

Thank you

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Appendix

The Economist

Weekly edition | The world in brief | War in the Middle East | War in Ukraine | United States | The world economy

Graphic detail | Disappearing act

Did international trade really kill American manufacturing?

By Donald Trump's telling it did. The data suggest otherwise

Apr 25th 2025

Share

Offshoring

Low Wage Countries (Bernard, Jensen, Schott, 2006)

Countries with less than 5% GDP per capita relative to U.S. during 1972-2001.

Afghanistan	China	India	Pakistan
Albania	Comoros	Kenya	Rwanda
Angola	Congo	Lao PDR	Samoa
Armenia	Equatorial Guinea	Lesotho	Sao Tome
Azerbaijan	Eritrea	Madagascar	Sierra Leone
Bangladesh	Ethiopia	Malawi	Somalia
Benin	Gambia	Maldives	Sri Lanka
Bhutan	Georgia	Mali	St. Vincent
Burkina Faso	Ghana	Mauritania	Sudan
Burundi	Guinea	Moldova	Togo
Cambodia	Guinea-Bissau	Mozambique	Uganda
Central African Rep	Guyana	Nepal	Vietnam
Chad	Haiti	Niger	Yemen

◂ Offshoring

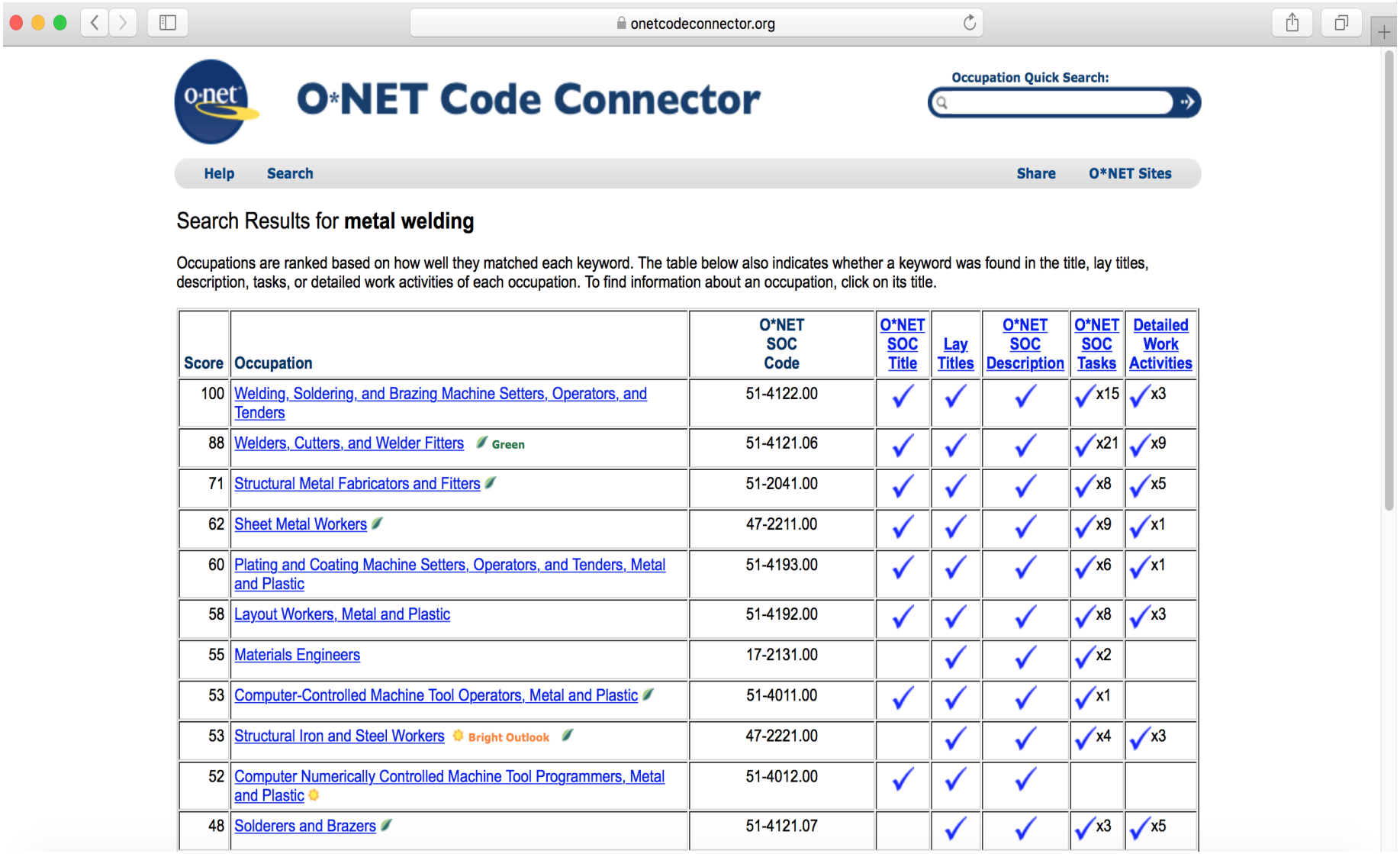
Occupational Offshorability

Table: Occupational Offshorability by 1-digit ISCO codes

1-digit ISCO	Occupation Description	Offshorability
1	Management at the highest level in companies, organizations and the public sector	-0.985
2	Work that requires the highest level of skills	-0.373
3	Work requiring intermediate skills	-0.693
4	Office work	0.076
5	Sales, service and care work	-0.915
6	Work in agriculture, horticulture, forestry, hunting and fishing that requires basic skills	-2.000
7	Craftsmanship	0.356
8	Process and machine operator work; transport and construction work	0.235
9	Other work	-1.155
10	Military work	NA

◂ Fact 2

Skill Construction



onetcodeconnector.org

O*NET Code Connector

Occupation Quick Search:

Help Search Share O*NET Sites

Search Results for **metal welding**

Occupations are ranked based on how well they matched each keyword. The table below also indicates whether a keyword was found in the title, lay titles, description, tasks, or detailed work activities of each occupation. To find information about an occupation, click on its title.

Score	Occupation	O*NET SOC Code	O*NET SOC Title	Lay Titles	O*NET SOC Description	O*NET SOC Tasks	Detailed Work Activities
100	Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders	51-4122.00	✓	✓	✓	✓x15	✓x3
88	Welders, Cutters, and Welder Fitters Green	51-4121.06	✓	✓	✓	✓x21	✓x9
71	Structural Metal Fabricators and Fitters	51-2041.00	✓	✓	✓	✓x8	✓x5
62	Sheet Metal Workers	47-2211.00	✓	✓	✓	✓x9	✓x1
60	Plating and Coating Machine Setters, Operators, and Tenders, Metal and Plastic	51-4193.00	✓	✓	✓	✓x6	✓x1
58	Layout Workers, Metal and Plastic	51-4192.00	✓	✓	✓	✓x8	✓x3
55	Materials Engineers	17-2131.00		✓	✓	✓x2	
53	Computer-Controlled Machine Tool Operators, Metal and Plastic	51-4011.00	✓	✓	✓	✓x1	
53	Structural Iron and Steel Workers Bright Outlook	47-2221.00		✓	✓	✓x4	✓x3
52	Computer Numerically Controlled Machine Tool Programmers, Metal and Plastic	51-4012.00	✓	✓	✓		
48	Solderers and Brazers	51-4121.07		✓	✓	✓x3	✓x5

Skill Construction

Validity of Instruments

Validity of Bartik-type instruments

- 135 shifters
- None of them dominates in terms of growth rates of offshoring

	(1)	(2)
	Raw	**Year FE**
Mean	1.408	0.0
Standard deviation	18.228	18.226
Interquartile range	0.429	0.761
Effective sample size (1/HHI) of s_d		
across products and periods	318.056	
across products	1.857	
Largest share s_d		
across products and periods	0.015	
across products	0.121	
No. of shocks	1500	
No. of products	135	
No. of periods	11	

◂ Identification

Robustness Checks

	IV (Dependent Variable: Average Cognitive Skills × 100, High-offshorable)							
	Sales per K		TFP		Offshoring (Alternate)		Weighted Regressions	
	Low	High	Low	High	Low	High	Low	High
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Offshoring (China)	0.2364***	-0.0773	0.2364***	-0.0525			0.2108***	-0.1370
	(0.0853)	(0.0824)	(0.0853)	(0.1071)			(0.0565)	(0.1043)
Offshoring (Low)					0.1906***	-0.0545		
					(0.0561)	(0.0759)		
Sector by Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓	✓	✓	✓	✓
Mean Y	50.26	48.68	50.26	49.13	48.81	50.05	48.81	50.06
First Stage F-stat	331.86	390.54	311.86	238.31	823.70	408.95	674.71	161.67
AR First Stage F-stat	9.54	1.05	9.54	0.29	14.02	0.63	17.02	2.15
N	15,809	17,800	15,809	16,821	16,816	16,816	16,816	16,816

main

Robustness Checks

	IV (Dependent Variable: Average Cognitive Skills × 100, High-offshorable)								
	Exclude Copenhagen		Firm Controls		L-Intensive		K-Intensive	IV Export	
	Low	High	Low	High	Low	High	All	Low	High
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Offshoring (China)	0.2608***	-0.1713	0.2769***	-0.1826	0.3350**	0.0014	-0.0163	0.2822***	-0.2131
	(0.0634)	(0.1363)	(0.0628)	(0.1349)	(0.1706)	(0.1599)	(0.2252)	(0.0623)	(0.1512)
Sector by Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mean Y	48.85	50.06	48.81	50.06	48.65	49.69	49.63	48.78	50.04
First Stage F-stat	635.99	125.23	666.11	127.91	67.95	47.11	74.53	336.04	50.04
AR First Stage F-stat	20.79	1.97	23.98	2.29	4.92	0.01	0.01	25.96	2.86
N	16,041	16.323	16,816	16,816	10,727	10,109	15,018	16,620	16,571

main

Baseline Economy

Social Planner's Problem

Dupuy and Galichon (2014) show that the competitive equilibrium maximizes the social welfare given by the sum of the total surplus and the entropy term:

$$\mathcal{W} = \max_{\pi(x,y)\in\mathcal{M}(f,g)} \left[E_\pi q(x,y) - \lambda E_\pi \log \pi(x,y) \right]$$

The equilibrium matching can be derived from the first order condition of this planner's problem.

Here, $a(x), b(y)$ correspond to the Lagrange multipliers on the "scarcity constraints" $\left[f(x) = \int \pi(x,y)dy,\ g(y) = \int \pi(x,y)dx \right]$ for the planner's problem. main

Global Economy

Workers

$$\pi(y|x) = \frac{\pi(x,y)}{f(x)} = \frac{\exp \frac{w(x,y)}{\lambda_x}}{\int \exp \frac{w(x,y)}{\lambda_x} dy}$$

$$f_0(x) = \frac{\exp \frac{w_0(x)-\alpha_x}{\lambda_x}}{\exp \frac{w_0(x)-\alpha_x}{\lambda_x} + \int \exp \frac{w(x,y)}{\lambda_x} dy} \overline{f}(x), \qquad f(x) = \int \pi(x,y)dy = \overline{f}(x) - f_0(x)$$

Foreign Workers

$$\pi^*(y|x) = \frac{\pi^*(x,y)}{f^*(x)} = \frac{\exp \frac{w^*(x,y)}{\lambda_x}}{\int \exp \frac{w^*(x,y)}{\lambda_x} dy}$$

$$f_0^*(x) = \frac{\exp \frac{w_0^*(x)-\alpha_x^*}{\lambda_x}}{\exp \frac{w_0^*(x)-\alpha_x^*}{\lambda_x} + \int \exp \frac{w^*(x,y)}{\lambda_x} dy} \overline{f^*}(x), \qquad f^*(x) = \int \pi^*(x,y)dy = \overline{f^*}(x) - f_0^*(x)$$

Global Economy

Firms

main

$$\pi(x|y) = \frac{\pi(x,y)}{g(y)} = \frac{\exp \frac{r(x,y)}{\lambda_y}}{\int \exp \frac{r(x,y)}{\lambda_y} dx}, \qquad \pi^*(x|y) = \frac{\pi^*(x,y)}{g^*(y)} = \frac{\exp \frac{r^*(x,y)}{\lambda_y}}{\int \exp \frac{r^*(x,y)}{\lambda_y} dx}$$

$$g_0(y) = \frac{\exp \frac{r_0(y)}{\lambda_y}}{D} \overline{g}(y)$$

$$g(y) = \int \pi(x,y) dx = \frac{\int \exp \frac{r(x,y)+\alpha_y}{\lambda_y} dx}{D} \overline{g}(y)$$

$$g^*(y) = \int \pi^*(x,y) dx = \frac{\int \exp \frac{r^*(x,y)+\alpha_y^*}{\lambda_y^*} dx}{D} \overline{g}(y)$$

$$\text{where} \quad D \equiv \exp \frac{r_0(y)}{\lambda_y} + \int \exp \frac{r(x,y)+\alpha_y}{\lambda_y} dx + \int \exp \frac{r^*(x,y)+\alpha_y^*}{\lambda_y} dx$$

Estimation Strategy

Estimation Steps

1. I derive the marginal densities $f(x), g(y)$ from the data and use the iterated proportional fitting procedure (IPFP) to recover the lagrangian multipliers $a(x), b(y)$ for a particular Γ assumed, which also simulates a corresponding matching between worker and firm.

2. Optimal $\hat{\Gamma}$ is obtained by a moment matching procedure, where I iterate this process until the difference between the model moments and the data moments are minimized.

3. I use the estimated $\hat{\Gamma}$ and $a(x), b(y)$ to derive a wage function which includes an unknown parameter λ_x. Using data on wage, I estimate the wage equation derived from the model to recover $\hat{\lambda}_x$.

◂ Estimation Strategy

Identification

Observed data:

- $\pi(x,y) \to f(x), g(y)$ (among matched); Φ/λ
- $f_0(x)$ (for occupation specific matching, do propensity matching) $\to \overline{f}(x)$
- $w(x,y)$ (wage) $\to A(x)$
- w_0 (reservation wage; min hourly wage 140DKK) $\to \alpha_x$

Parameters to be estimated: $\Phi, A(x), \alpha_x$ (Normalization: $\lambda = 1$)

Unobserved quantities:

- Firm's profit and the outside option: $r(x,y), r^*(x,y), r_0(y), g_0(y)$
- Foreign worker's wage and the outside option: $w^*(x,y), w_0^*(x), f_0^*(x)$

What cannot be identified:

- Levels of C, α_y, α_y^*, since the mass of potential firms can be arbitrary
- Levels of C^*, α_x^*, since the mass of foreign workers can be arbitrary
- By assuming that $\overline{g}, \overline{f}^*, \alpha_x^*$, etc. remain constant over time, we can identify the *changes* in e.g. $c_F = C - C^*$.