KOF

The Contribution of Trade to Wage Inequality: The Role of Skill, Gender, and Nationality

Michael W. Klein – Tufts University and NBER

Christoph Moser – ETH Zurich and CESifo

Dieter Urban† – RWTH Aachen and CESifo

April 26, 2012

Comparative Analysis of Enterprise Data (CAED)

Federal Employment Agency, Nuremberg

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

The Export Wage Premium

- Manufacturing exporters differ from non-exporters:
  - Larger, more productive, pay higher wages, better technology.
- Bernard and Jensen (1995) found an export wage premium of 7% - 11% for manufacturing plants in the United States (plant-level data).
  - Confirmed for Chile, Colombia, Denmark, Estonia, Germany, Korea, Mexico, Portugal, Slovenia, Spain, Sweden, Taiwan and the United Kingdom.
  - Export wage premium of 6% for US manufacturing for 2002.

Source of Wage Inequality?

- Wage differentials between exporters and other firms could contribute to rising inequality in industrial countries (Krugman, 1995, 2008).
- Recent theoretical contributions propose a Melitz(2003)-framework with labor market frictions (e.g., Egger and Kreickemeier, 2009; Felbermayr, Prat and Schmerer, 2011; Helpman, Itskhoki and Redding, 2010a,b).
  - Helpman, Itskhoki and Redding emphasize heterogeneity across both workers and firms.
  - Unequal effect of trade on workers with different abilities.
  - Workers of intermediate (high) abilities lose (win).

Source of Wage Inequality?

- Bernard and Jensen (1997) argue that manufacturing exporters use highly skilled, non-production-line workers relatively more intensively than lower skilled production-line workers → Difference in demand for skilled labor between exporting and non-exporting plants, rather than differences in the exporter wage premia across skill levels.
- Distributional effects magnified or diminished, if the export wage premium differs across categories of workers in firms that export.
  - Wage inequality à la Bernard-Jensen bolstered by an export wage premium for high-skilled workers in exporting firms combined with a wage discount for their lower co-workers. Mitigated by the converse.

Skill Level Not Considered Previously

- Plant-level studies could not study skill structure of the export trade premium:
  - Export wage premia for non-production-line vs. production-line workers (e.g., Bernard and Jensen, 1995, 1999, 2004; Hansson and Lundin, 2004).
- Schank, Schnabel and Wagner (2007) offer first evidence based on linked employer-employee data:
  - Seperate regressions for blue-collar and white-collar workers.
  - Evidence for small premia for both groups.
  - German LIAB for the years 1995-1997.
- Munch and Skaksen (2008) find some evidence that skill intensity matters for the export wage premium:
  - Danish matched worker-firm data for the years 1995-2002.
  - Seperate regressions for three educational groups.

Main Findings and Contributions

- Differences in trade wage premium (or discount) across skill levels → evidence for *within*-group and *between*-group wage inequality.
- Up to 30 percent of the overall skill premia associated with exporting.
- These differences would tend to exacerbate effects of trade on inequality as trade expands.
- But while the export activity contributes to conditional *wage inequality* along the dimension of skill, it reduces gender-based and nationality-based conditional wage inequality (*wage discrimination*).

Linked Employer-Employee Data (LIAB)

- IAB establishment panel from German Labor Agency:
  - Representative, stratified sample of West German establishments included in the employment statistics register from 1993 to 2007.
  - Stratum defined over 16 industries, 10 categories of establishment size and 16 German regions (Laender).
  - Participation of firms voluntary, but response rate quite high.
  - Establishments that refuse to answer are replaced by random draws from the same stratum.
  - Control variables at plant-level in following regressions: size (log total employment), work council, single plant company, in a holding company, technology.
  - Variable of main interest: export share.

Linked Employer-Employee Data (LIAB)

- LIAB employee data (Cross-sectional model) (cont.):
  - Control variables at the individual-level: gender, nationality, tenure, experience and occupation.
  - Education: 6 groups
  - Occupation: 340 occupations, but two groupings:
    - *Arbeiter:* Lower-skilled – unskilled, blue-collar workers who might have some vocational training.
    - *Angestellte:* Higher-skilled – includes master craftsmen, white-collar workers.
  - High correspondence between a worker‘s occupation and whether classified as *Arbeiter* or *Angestellter*.
    - More than 90 percent of the workers in more than 200 of the 340 occupations are classified as either Arbeiter or Angestellter.
    - Fewer than 20 occupations have no more than two-thirds of one type.
  - Variable of main interest: Four categories of workplace skill level.

Table 1: Skill Levels by Education / Occupation

Education	Occupation Classification (*Prop. Of Sample*)	
	Arbeiter	*Angestellter*
≤ 10 years, no vocational training	Low-skilled (*0.34*)	*No observations*
≤ 10 years, vocational training High School degree, no voc. training High School degree, vocational training	Medium-skilled (*0.35*)	High-skilled (*0.24*)
College Degree University Degree	*No observations*	Univ. Educated (*0.07*)

Source: LIAB, Institute for Employment Research.

Export Wage Premium by Skill Level (eq. 2)

$$\ln W_{i,j,t} = \sum_{Z=1}^{4} \beta_Z \left(S_{i \in Z,t} \times X_{j,t} \right) + \sum_{Z=2}^{4} \alpha_Z S_{i \in Z,t} + \Psi I_{i,t} + \Omega P_{j,t} + \tau_t + F_{i,j,t} + \varepsilon_{i,j,t}$$

- $W_{i,j,t}$ = log wage of worker *i* employed at plant *j* in year *t*.
- $X_{j,t}$ = share of exports at plant *j* in year *t*.
- $S_{i \in Z,t}$ = 1 if worker *i* has skill level *Z*, else 0.
  - *Z* = 1 for low-skilled (omitted category), 2 for medium-skilled, 3 for high-skilled, and 4 for college or university degree.
- β_L, β_M , β_H , and β_U are four skill-specific export wage premia.
- α_M, α_H and α_U are three skill coefficients not associated with exporting.
- $I_{i,t}$ = characteristics of worker *i* in year *t* other than skill.
- $P_{j,t}$ = characteristics of the plant *j*, where *i* works.
- Year fixed effects in all specifications.

Export Wage Premium by Skill Level (eq. 2)

$$\ln W_{i,j,t} = \sum_{Z=1}^{4} \beta_Z \left(S_{i \in Z,t} \times X_{j,t} \right) + \sum_{Z=2}^{4} \alpha_Z S_{i \in Z,t} + \Psi I_{i,t} + \Omega P_{j,t} + \tau_t + F_{i,j,t} + \varepsilon_{i,j,t}$$

- Other fixed effects: plant, plant-occupation and plant-individual (main specification) or “spell”-fixed effect.
- Abowd, Kramarz and Margolis (1999) show that a failure to control for individual and firm heterogeneity can lead to a substantial bias.
- Andrews, Schank and Upward (2006) propose estimation method.
- Caveat of estimates à la Abowd, Kramarz and Margolis:
  - Covariates are assumed to be strictly exogenous (e.g., Winter-Ebmer and Zweimüller, 1999), i.e., any sort of self-selection not allowed.
  - Frias, Kaplan and Verhoogen (2009) relax this assumption.

Table 2: Effect of Export Share on Wages, By Skill Level (cont.)

Panel C: *P×I*, Plant-Individual FE $R^2 = 0.93$ n = 8,041,676

Skill Level	α_Z *(Skill)*	β_Z *(Skill×Exp)*	$\beta_{Medium} - \beta_Z$	$\beta_{High} - \beta_Z$	$\beta_{Univ.} - \beta_Z$
Low-skilled	–	-0.012†	0.016*	0.059**	0.069**
(s.e.)	–	(0.008)	(0.007)	(0.009)	(0.009)
Medium-skilled	0.016**	0.004	–	0.043**	0.053**
(s.e.)	(0.005)	(0.007)	–	(0.007)	(0.007)
High-skilled	0.089**	0.047**	–	–	0.010†
(s.e.)	(0.006)	(0.007)	–	–	(0.006)
Univ. Educated	0.161**	0.058**	–	–	–
(s.e.)	(0.012)	(0.006)	–	–	–

† = sig. at 90% to 95% level of confidence
* = sig. at 95% to 99% level of confidence.
** = significant at ≥ 99% level of confidence
See Table 4 for list of other regressors.

Figure 4: Interpretation of Equation [2] Estimates

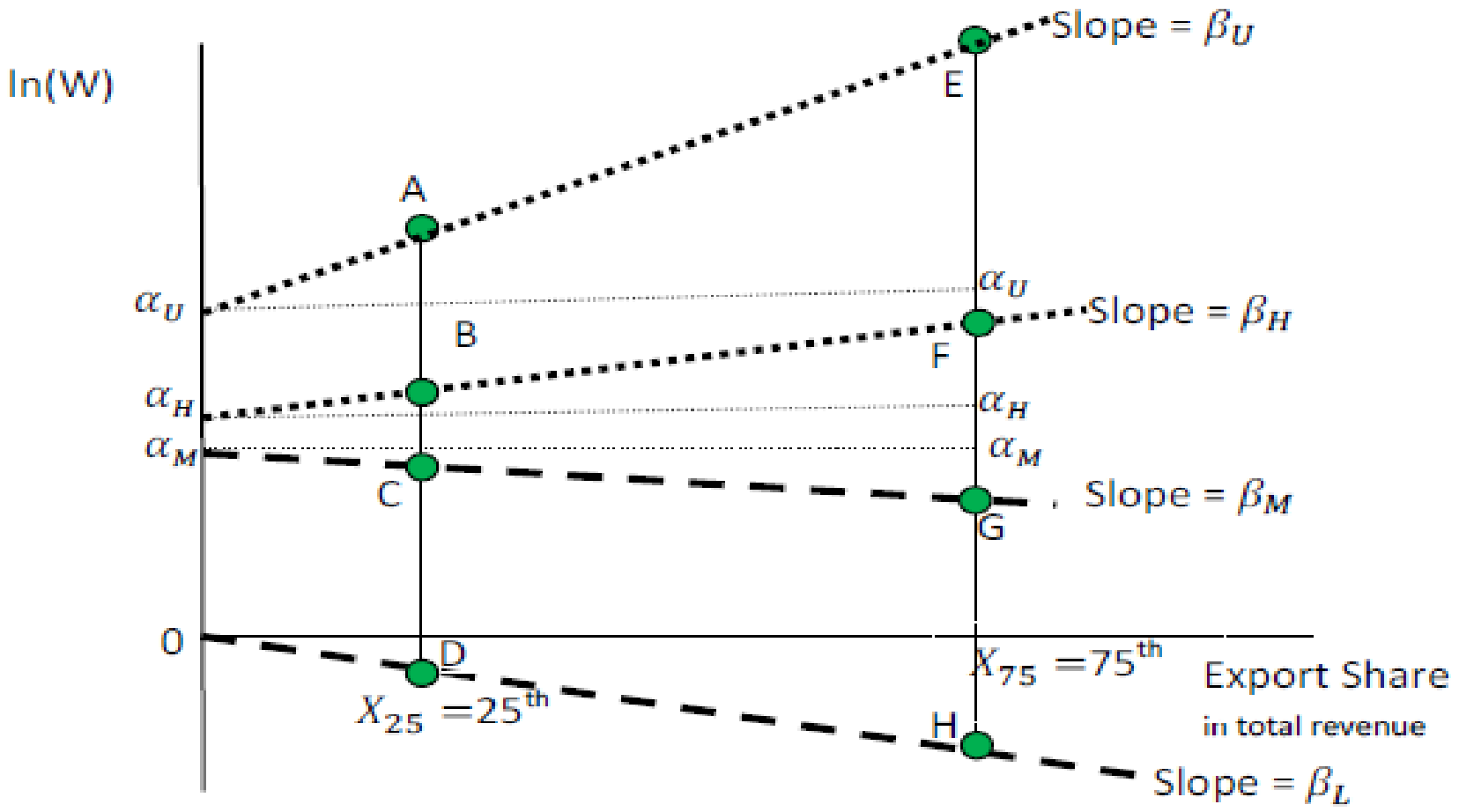


Table 3: Estimates of Export Wage Premiums

Panel A: Contribution of Exports to *Within*-group Wage Inequality

I. Export Wage Premiums (percent)

$$\beta_Z \times X_i \times 100\%$$

Skill Category	Export Share		
	25th Percentile	50th Percentile	75th Percentile
Low-Skilled	-0.34†	-0.58†	-0.75†
Medium-Skilled	0.12	0.20	0.26
High-Skilled	1.42**	2.37**	3.08**
Univ. Educated	1.73**	2.88**	3.74**

II. Percentage of *Within*-group Wage Inequality due to Export Wage Premium

$$\left[\left(\beta_Z \times X_i \right) \Big/ \left(\alpha_Z + \left(\beta_Z \times X_i \right) \right) \right] \times 100\%$$

Skill Category	Export Share		
	25th Percentile	50th Percentile	75th Percentile
Medium-Skilled	6.9	11.1	13.9
High-Skilled	13.7**	20.9**	25.6**
Univ. Educated	9.7**	15.2**	18.9**

Table 3: Estimates of Export Wage Premiums (cont.)

Panel B: Contribution of Exports to *Between*-group Wage Inequality

III. Differences in Export Wage Premiums *Between* Skill Groups by Export Share

$$\left(\left[\beta_{Z'} - \beta_Z\right] \times X_i\right) \times 100\%$$

	$\beta_{Medium} - \beta_Z$			$\beta_{High} - \beta_Z$			$\beta_{Univ.} - \beta_Z$		
Percentile	25th	50th	75th	25th	50th	75th	25th	50th	75th
Low-Skilled	0.5*	0.8*	1.0*	1.8**	2.9**	3.8**	2.1**	3.5**	4.5**
Medium-Skilled				1.3**	2.2**	2.8**	1.6**	2.7**	3.5**
High-Skilled							3.1†	5.1†	6.7†

IV. Percentage of *Between*-group Wage Inequality due to Differences in Export Wage Premiums

$$\left[\left(\left[\beta_{Z'} - \beta_Z\right] \times X_i\right) \Big/ \left(\left[\alpha_{Z'} - \alpha_Z\right] + \left(\left[\beta_{Z'} - \beta_Z\right] \times X_i\right)\right)\right] \times 100\%$$

				High − *Z*			*Univ.* − *Z*		
Percentile	25th	50th	75th	25th	50th	75th	25th	50th	75th
Medium-Skilled				15**	23**	28**	10**	16**	19**
High-Skilled							4†	7†	9†

And the Losers Are …

Table 4: Largest Export Wage Discounts by Occupation

Occupation	*Wage Discount (in percent)*	*Predominant Skill-group*
Wood preparers	- 9.39%	Low-skilled
Flour, food processors	- 4.88%	Low-skilled
Office auxiliary workers	- 4.06%	Low-/high-skilled
Meat, sausage good makers	- 3.64%	Low-skilled
Packagers, goods receivers	- 3.29%	Low-skilled
Plastic processors	- 3.23%	Low-skilled
Toolmakers	- 2.51%	Medium-skilled
Stores, transport workers	- 2.25%	Low-skilled
Transportation equipment drivers	- 2.07%	Low-skilled

Note: Based on results from Table 2, Panel C, plant-individual fixed effects, at least 15,000 employees per occupation; only manufacturing plants with at least 10 employees included; all reported coefficients on wage premia/discounts are significant at least at the 90 percent confidence level.

And the Winners Are …

Table 5: Largest Export Wage Premia by Occupation

Occupation	*Wage Premium (in percent)*	*Predominant Skill-group*
Foreman, master mechanics	11.63%	Medium-skilled
Management consultants	8.39%	Univ.educated
Electrical engineers	8.28%	High-skilled
Economic and social scientists	8.08%	Univ.educated
Other engineers	7.17%	Univ.educated
Entrepreneurs, managing directors	7.15%	Univ.educated
Cost accountants, valuers	6.74%	High-skilled
Wholesale and retail trade buyers	6.60%	High-skilled
Data processing specialists	6.44%	High-skilled
Mechanical, motor engineers	6.23%	Univ.educated

Note: Based on results from Table 2, Panel C, plant-individual fixed effects, at least 15,000 employees per occupation; only manufacturing plants with at least 10 employees included; all reported coefficients on wage premia/discounts are significant at least at the 90 percent confidence level.

Robustness

- Is the plant‘s technology state-of-the-art?
- Is product innovation relevant?
- Are observable productivity gains driving the results?
- Is it rather size-premium or skill-premium?
- Occupation-specific time-trends as an alternative hypothesis?

→ No, our results on export wage premia across skill-groups hold.

Table 8: Alternative Hypotheses to the Export Wage Premia, by Skill Level

β_z(SkillxExp)	Benchmark Tab. 5 C	Y=Labor productivity	Y=Size (log employment)	Y=Share of Univ. Educated	Y=Technology	Y=New tech/prod.	Occupation time trend
Low-skilled	-0.012†	-0.010	-0.013†	-0.038*	-0.026*	-0.008	-0.010
(s.e.)	(0.007)	(0.007)	(0.007)	(0.018)	(0.013)	(0.024)	(0.006)
Medium-skilled	0.004	0.005	0.004	-0.003	0.007	-0.012	0.006
(s.e.)	(0.007)	(0.007)	(0.007)	(0.015)	(0.012)	(0.023)	(0.006)
High-skilled	0.047**	0.048**	0.048**	0.025†	0.037**	0.066**	0.047**
(s.e.)	(0.007)	(0.008)	(0.007)	(0.013)	(0.013)	(0.020)	(0.008)
Univ. Educated	0.058**	0.057**	0.057**	0.044**	0.043**	0.087**	0.055**
(s.e.)	(0.006)	(0.008)	(0.007)	(0.008)	(0.014)	(0.031)	(0.007)
γ_z(SkillxY)							
Low-skilled	—	-0.000	0.037**	-0.156*	-0.006**	0.000	—
(s.e.)		(0.000)	(0.007)	(0.078)	(0.002)	(0.020)	
Medium-skilled	—	0.000	0.035**	0.003	-0.002	0.008	—
(s.e.)		(0.000)	(0.007)	(0.108)	(0.002)	(0.016)	
High-Skilled	—	0.001**	0.033**	0.332**	-0.001	0.007	—
(s.e.)		(0.000)	(0.006)	(0.068)	(0.002)	(0.016)	
Univ. Educated	—	0.001*	0.035**	0.314**	-0.002	-0.005	—
(s.e.)		(0.000)	(0.007)	(0.524)	(0.003)	(0.024)	
$\hat{o}z$ (SkillxYxExp)							
Low-skilled	—	—	—	0.220*	0.007	—	—
(s.e.)				(0.110)	(0.005)		
Medium-skilled	—	—	—	0.043	0.006	—	—
(s.e.)				(0.122)	(0.005)		
High-Skilled	—	—	—	0.012	0.005	—	—
(s.e.)				(0.087)	(0.005)		
Univ. Educated	—	—	—	-0.044	0.006	—	—
(s.e.)				(0.035)	(0.005)		
No. of Obs.	7,071,930	7,071,930	7,071,930	7,071,930	6,457,769	2,426,542	7,071,930

† sig. at 90% to 95% level of significance; ** sig. at 95% to 99% level of significance; *** significant at ≥ 99% level of significance. Firm-employee spell- and year-fixed effects in all specifications. See Table 4 for list of other regressors. Only manufacturing plants with at least 10 employees are included. Estimates weight observations by inverse drawing probability. The specification *Y=new tech/prod.* covers only 5 years.

Gender, Nationality, and Export Wage Premia

- Increasing competitive pressure makes it more costly for individuals and firms to discriminate (Becker, 1957).
- Black and Strahan (2001) find that banking sector deregulation led to a stronger fall in wages for men than women.
- Black and Brainerd (2004) show that the gender wage gap decreased from 1976 to 1993 in the United States in industries with higher import competition → reduction in ability to discriminate.
- Mixed evidence on Becker‘s hypothesis for emerging markets (Joliffe and Campos, 2005; Berik et al., 2004).

Gender, Nationality, and Export Wage Premia by Skill Level (eq. 3)

$$\ln W_{i,j,t} = \sum_{Z=1}^{4} \beta_Z \left(S_{i \in Z,t} \times X_{j,t} \right) + \sum_{Z=2}^{4} \alpha_Z S_{i \in Z,t} + \Psi I_{i,t} + \Omega P_{j,t} + \tau_t + F_{i,j,t} +$$

$$+ D_i \left(\sum_{Z=1}^{4} \beta_Z^D \left(S_{i \in Z,t} \times X_{j,t} \right) + \sum_{Z=1}^{4} \alpha_Z^D S_{i \in Z,t} \right) + \varepsilon_{i,j,t}$$

- where D_i equals
  - 1 if the individual is a women (in one set of regressions considering gender differences), or
  - 1 if the individual is not a German citizen (in another set of regressions anlyzing differences in wages between foreigners and others).
- Plant-occupation fixed effects.

Table 7: Export Wage Premium for Women

***P*×*O*, Plant-Occupation FE**		R^2=0.774 No. obs. = 8,041,676		
Skill Level	α_Z *(Skill)*	β_Z *(Skill×Exp)*	α_Z^D *(Women)*	β_Z^D *(Women)*
Low Skill	–	-0.003	-0.178**	0.052**
(s.e.)	–	(0.008)	(0.005)	(0.011)
Medium Skill	0.079**	-0.024**	-0.178**	0.052*
(s.e.)	(0.004)	(0.008)	(0.011)	(0.028)
High Skill	0.227**	0.010	-0.303**	0.067**
(s.e.)	(0.006)	(0.009)	(0.008)	(0.014)
Univ. Educated	0.371**	0.055**	-0.299*	0.400*
(s.e.)	(0.009)	(0.013)	(0.008)	(0.021)

Export Wage Premium for Women, by Export Share Percentile

Skill Level	25th Percentile	50th Percentile	75th Percentile
Low Skill	0.015**	0.026**	0.034**
(s.e.)	(0.003)	(0.005)	(0.007)
Medium Skill	0.008	0.013	0.017
(s.e.)	(0.006)	(0.010)	(0.013)
High Skill	0.022**	0.036**	0.048**
(s.e.)	(0.004)	(0.006)	(0.008)
Univ. Educated	0.026**	0.049**	0.059**
(s.e.)	(0.005)	(0.009)	(0.012)

Note: Other control variables as in Table 4.

Table 8: Export Wage Premium for Foreigners

***P*×*O*, Plant-Occupation FE**	R^2=0.774	No. obs. = 8,041,676		
Skill Level	α_Z *(Skill)*	β_Z *(Skill×Exp)*	α_Z^D *(Foreigner)*	β_Z^D *(Foreigner)*
Low Skill	–	0.016*	-0.008	-0.008
(s.e.)	–	(0.008)	(0.006)	(0.006)
Medium Skill	0.076**	-0.023**	-0.026**	0.035**
(s.e.)	(0.004)	(0.007)	(0.005)	(0.012)
High Skill	0.192**	0.030**	-0.025†	0.058*
(s.e.)	(0.006)	(0.008)	(0.013)	(0.023)
Univ. Educated	0.354**	0.058**	-0.020	0.074*
(s.e.)	(0.009)	(0.013)	(0.019)	(0.033)

Export Wage Premium for Foreigners, by Export Share Percentile

Skill Level	25th Percentile	50th Percentile	75th Percentile
Low Skill	0.002	0.004	0.005
(s.e.)	(0.002)	(0.004)	(0.005)
Medium Skill	0.004	0.006	0.008
(s.e.)	(0.004)	(0.007)	(0.009)
High Skill	0.025**	0.042**	0.055**
(s.e.)	(0.007)	(0.012)	(0.015)
Univ. Educated	0.037**	0.062**	0.082**
(s.e.)	(0.010)	(0.016)	(0.021)

Note: Other control variables as in Table 4.

Conclusions

- Signficant export wage premium for higher-skilled workers and a significant export wage discount for lower-skilled workers, using a matched employer-employee dataset for German manufacturing establishments.
- Evidence for *within*-group and *between*-group wage inequality.
- Up to 30 percent of the overall skill premia associated with exporting.
- These differences would tend to exacerbate effects of trade on inequality as trade expands.
- But while the export activity contributes to conditional *wage inequality* along the dimension of skill, it reduces gender-based and nationality-based conditional wage inequality (*wage discrimination*).

Thank you for your attention.

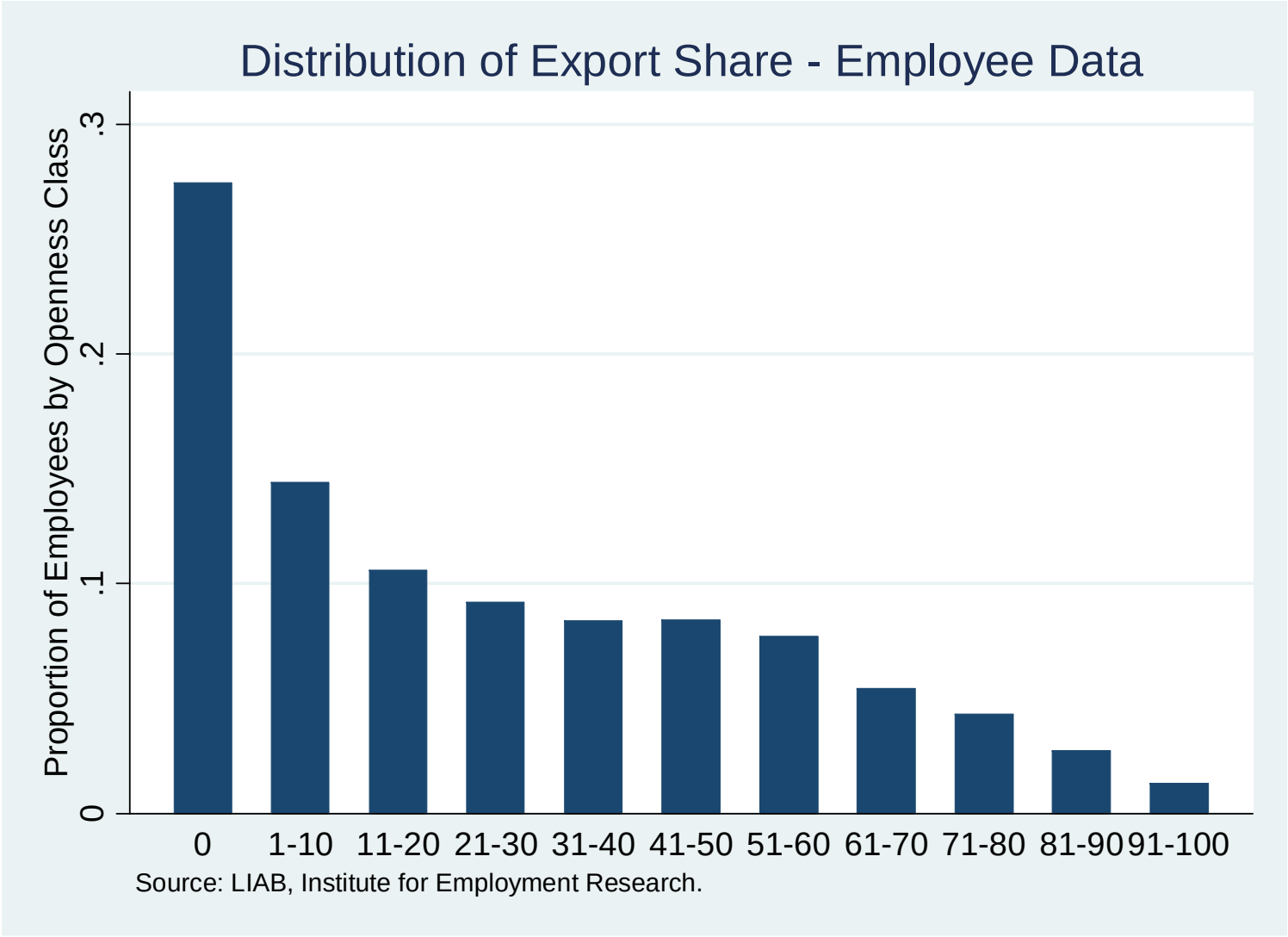

Distribution of Export Share - Employee Data
Proportion of Employees by Openness Class
0
.1
.2
.3
0
1-10
11-20
21-30
31-40
41-50
51-60
61-70
71-80
81-90
91-100
Source: LIAB, Institute for Employment Research.

Table 2: Effect of Export Share on Wages, By Skill Level (cont.)

Panel B: *P×O*, Plant-Occupation FE $R^2 = 0.77$ n = 8,041,676

Skill Level	α_Z *(Skill)*	β_Z *(Skill×Exp)*	$\beta_{Medium} - \beta_Z$	$\beta_{High} - \beta_Z$	$\beta_{Univ.} - \beta_Z$
Low-skilled	–	0.014†	-0.034**	0.018†	0.048**
(s.e.)	–	(0.007)	(0.009)	(0.011)	(0.015)
Medium-skilled	0.074**	-0.020**	–	0.053**	0.082**
(s.e.)	(0.004)	(0.007)	–	(0.010)	(0.014)
High-skilled	0.191**	0.032**	–	–	0.029*
(s.e.)	(0.006)	(0.008)	–	–	(0.012)
Univ. Educated	0.353**	0.062**	–	–	–
(s.e.)	(0.008)	(0.012)	–	–	–

† = sig. at 90% to 95% level of confidence
* = sig. at 95% to 99% level of confidence.
** = significant at ≥ 99% level of confidence
See Table 4 for list of other regressors.

CONTINUED NEXT SLIDE

Table 2: Effect of Export Share on Wages, By Skill Level

Panel A: *P*, Plant FE $R^2 = 0.67$ n = 8,041,676

Skill Level	α_Z *(Skill)*	β_Z *(Skill×Exp)*	$\beta_{Medium} - \beta_Z$	$\beta_{High} - \beta_Z$	$\beta_{Univ.} - \beta_Z$
Low-skilled	–	-0.004	-0.052**	0.096**	0.095**
(s.e.)	–	(0.008)	(0.009)	(0.012)	(0.016)
Medium-skilled	0.131**	-0.056**	–	0.148**	0.147**
(s.e.)	(0.004)	(0.009)	–	(0.013)	(0.015)
High-skilled	0.330**	0.092**	–	–	-0.001
(s.e.)	(0.006)	(0.010)	–	–	(0.014)
Univ. Educated	0.622**	0.092**	–	–	–
(s.e.)	(0.008)	(0.014)	–	–	–

† = sig. at 90% to 95% level of confidence
* = sig. at 95% to 99% level of confidence.
** = significant at ≥ 99% level of confidence
See Table 4 for list of other regressors.

CONTINUED NEXT SLIDE

Is It Technology (eq. 4)?

$$\ln W_{i,j,t} = \sum_{Z=1}^{4} \beta_Z \left(S_{i \in Z,t} \times X_{j,t} \right) + \sum_{Z=2}^{4} \alpha_Z S_{i \in Z,t} + \Psi I_{i,t} + \Omega P_{j,t} + \tau_t + F_{i,j,t} +$$

$$+ T_{j,t} \left(\sum_{Z=1}^{4} \beta_Z^T \left(S_{i \in Z,t} \times X_{j,t} \right) + \sum_{Z=2}^{4} \alpha_Z^T S_{i \in Z,t} \right) + \varepsilon_{i,j,t}$$

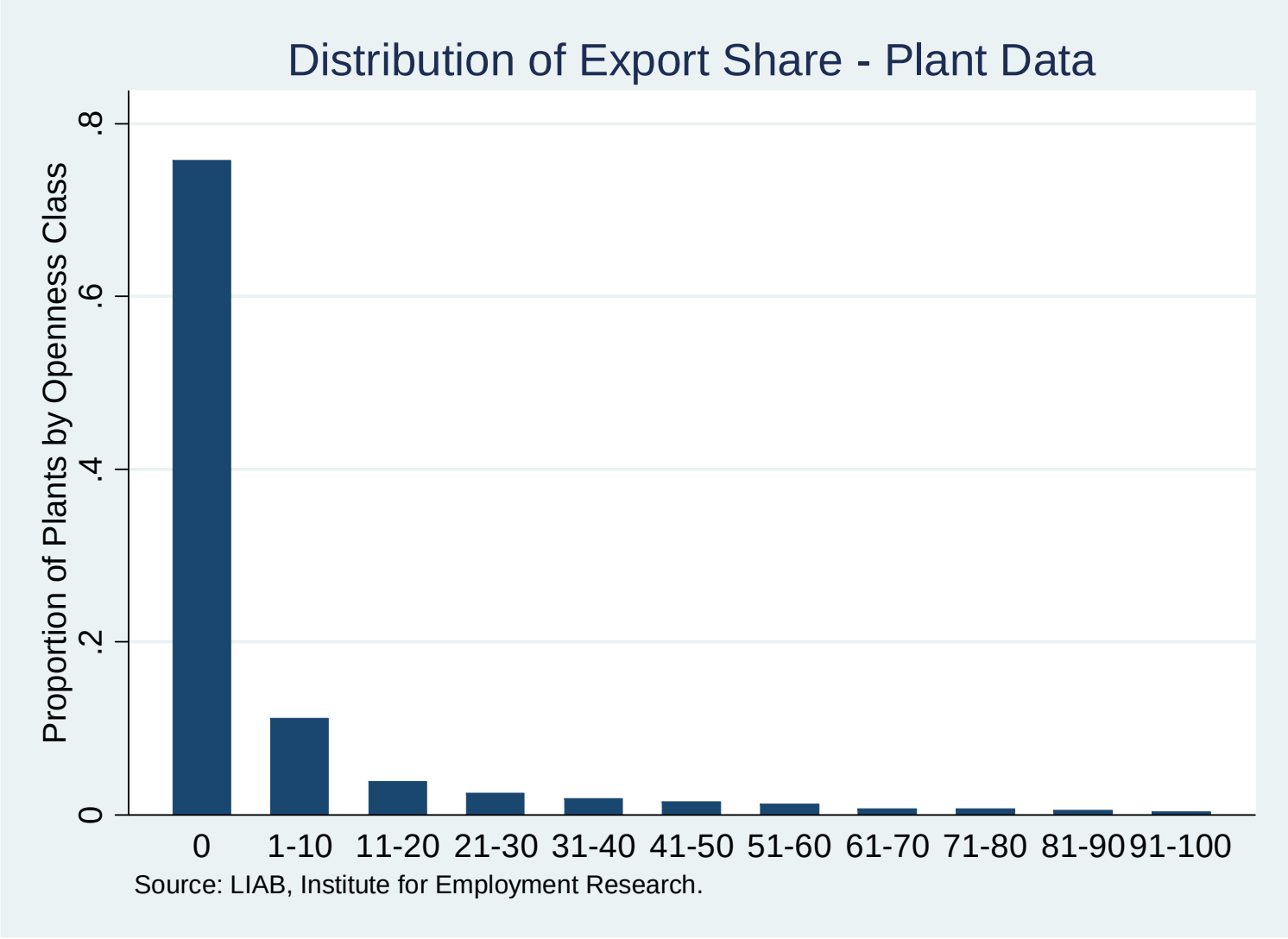
- where $T_{j,t}$ is variable that runs from 1 (state-of-the-art) to 5 (obsolete), reporting the the establishment‘s self-assessment of its technology as compared to its industry competitors.

- In brief, technology apparently does not explain the observed export wage premia.

Table 8: Alternative Hypotheses to the Export Wage Premia, by Skill Level

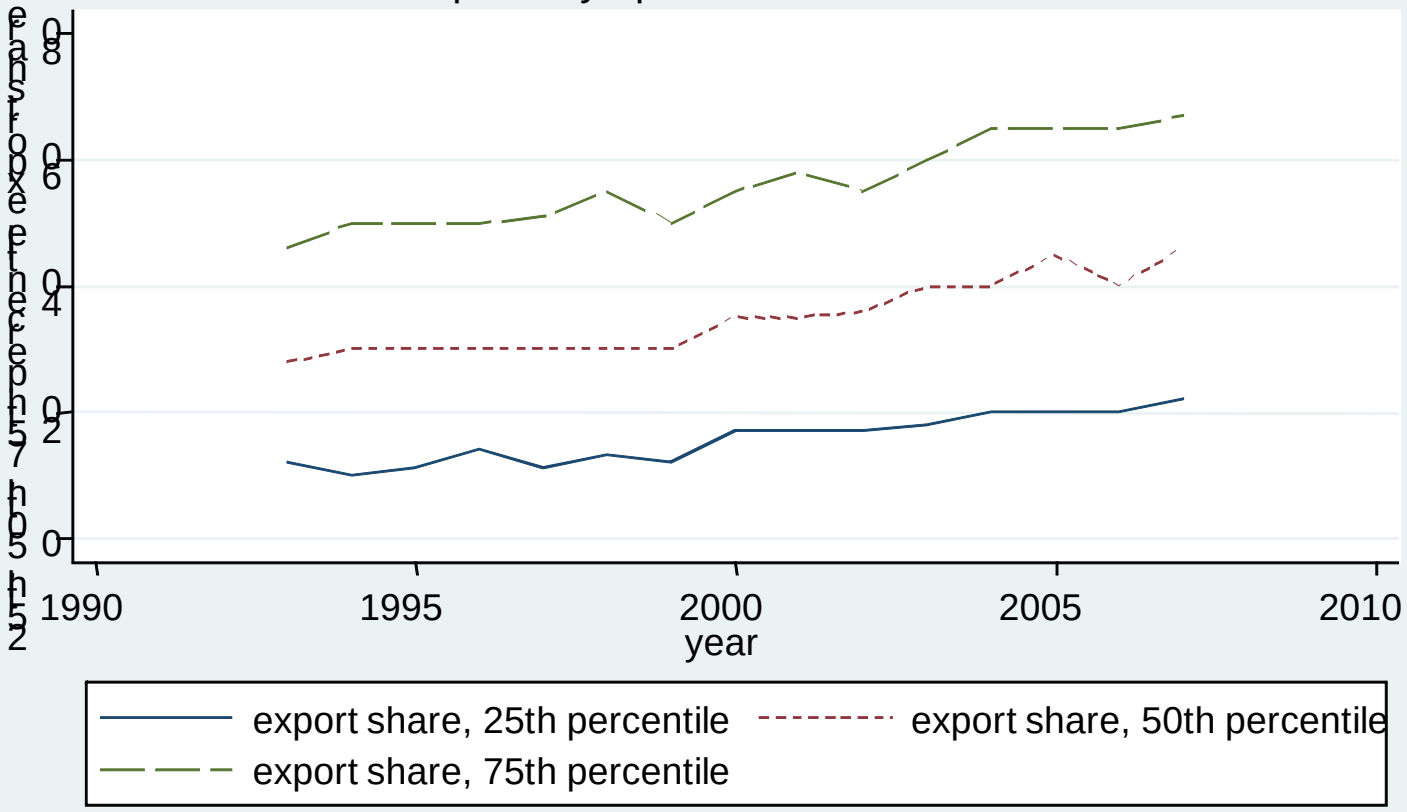
β_z(SkillxExp)	Benchmark Tab. 5 C	Y=Labor productivity	Y=Size (log employment)	Y=Share of Univ. Educated	Y=Technology	Y=New tech/prod.	Occupation time trend
Low-skilled	-0.012†	-0.010	-0.013†	-0.038*	-0.026*	-0.008	-0.010
(s.e.)	(0.007)	(0.007)	(0.007)	(0.018)	(0.013)	(0.024)	(0.006)
Medium-skilled	0.004	0.005	0.004	-0.003	0.007	-0.012	0.006
(s.e.)	(0.007)	(0.007)	(0.007)	(0.015)	(0.012)	(0.023)	(0.006)
High-skilled	0.047**	0.048**	0.048**	0.025†	0.037**	0.066**	0.047**
(s.e.)	(0.007)	(0.008)	(0.007)	(0.013)	(0.013)	(0.020)	(0.008)
Univ. Educated	0.058**	0.057**	0.057**	0.044**	0.043**	0.087**	0.055**
(s.e.)	(0.006)	(0.008)	(0.007)	(0.008)	(0.014)	(0.031)	(0.007)
γ_z(SkillxY)							
Low-skilled	—	-0.000	0.037**	-0.156*	-0.006**	0.000	—
(s.e.)		(0.000)	(0.007)	(0.078)	(0.002)	(0.020)	
Medium-skilled	—	0.000	0.035**	0.003	-0.002	0.008	—
(s.e.)		(0.000)	(0.007)	(0.108)	(0.002)	(0.016)	
High-Skilled	—	0.001**	0.033**	0.332**	-0.001	0.007	—
(s.e.)		(0.000)	(0.006)	(0.068)	(0.002)	(0.016)	
Univ. Educated	—	0.001*	0.035**	0.314**	-0.002	-0.005	—
(s.e.)		(0.000)	(0.007)	(0.524)	(0.003)	(0.024)	
$\hat{o}z$ (SkillxYxExp)							
Low-skilled	—	—	—	0.220*	0.007	—	—
(s.e.)				(0.110)	(0.005)		
Medium-skilled	—	—	—	0.043	0.006	—	—
(s.e.)				(0.122)	(0.005)		
High-Skilled	—	—	—	0.012	0.005	—	—
(s.e.)				(0.087)	(0.005)		
Univ. Educated	—	—	—	-0.044	0.006	—	—
(s.e.)				(0.035)	(0.005)		
No. of Obs.	7,071,930	7,071,930	7,071,930	7,071,930	6,457,769	2,426,542	7,071,930

† sig. at 90% to 95% level of significance; ** sig. at 95% to 99% level of significance; *** significant at ≥ 99% level of significance. Firm-employee spell- and year-fixed effects in all specifications. See Table 4 for list of other regressors. Only manufacturing plants with at least 10 employees are included. Estimates weight observations by inverse drawing probability. The specification *Y=new tech/prod.* covers only 5 years.


Distribution of Export Share - Plant Data
Proportion of Plants by Openness Class
0
.2
.4
.6
.8
0
1-10
11-20
21-30
31-40
41-50
51-60
61-70
71-80
81-90
91-100
Source: LIAB, Institute for Employment Research.

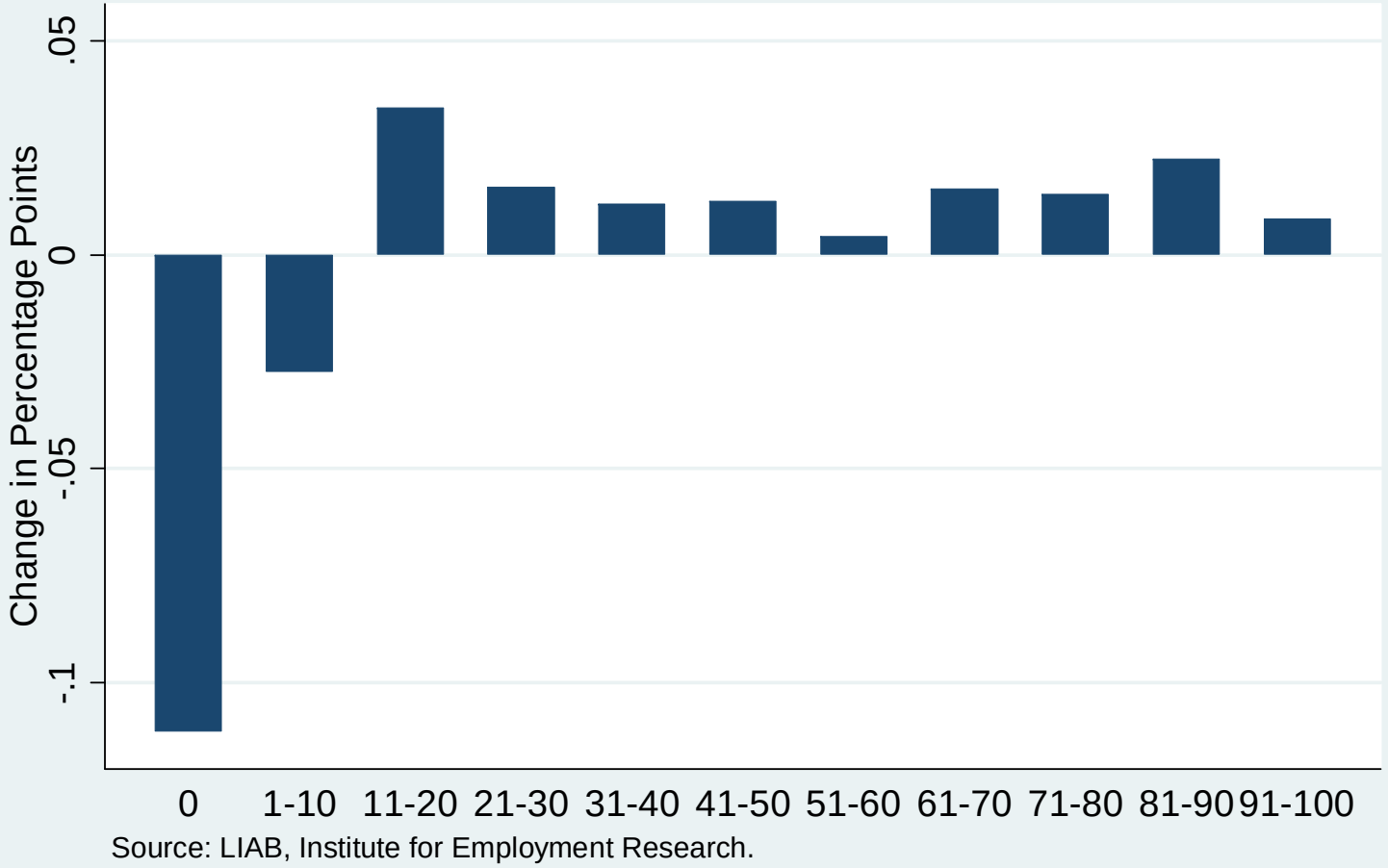
Evolution of Export Share

Share of exports by openness class from 1993 to 2007



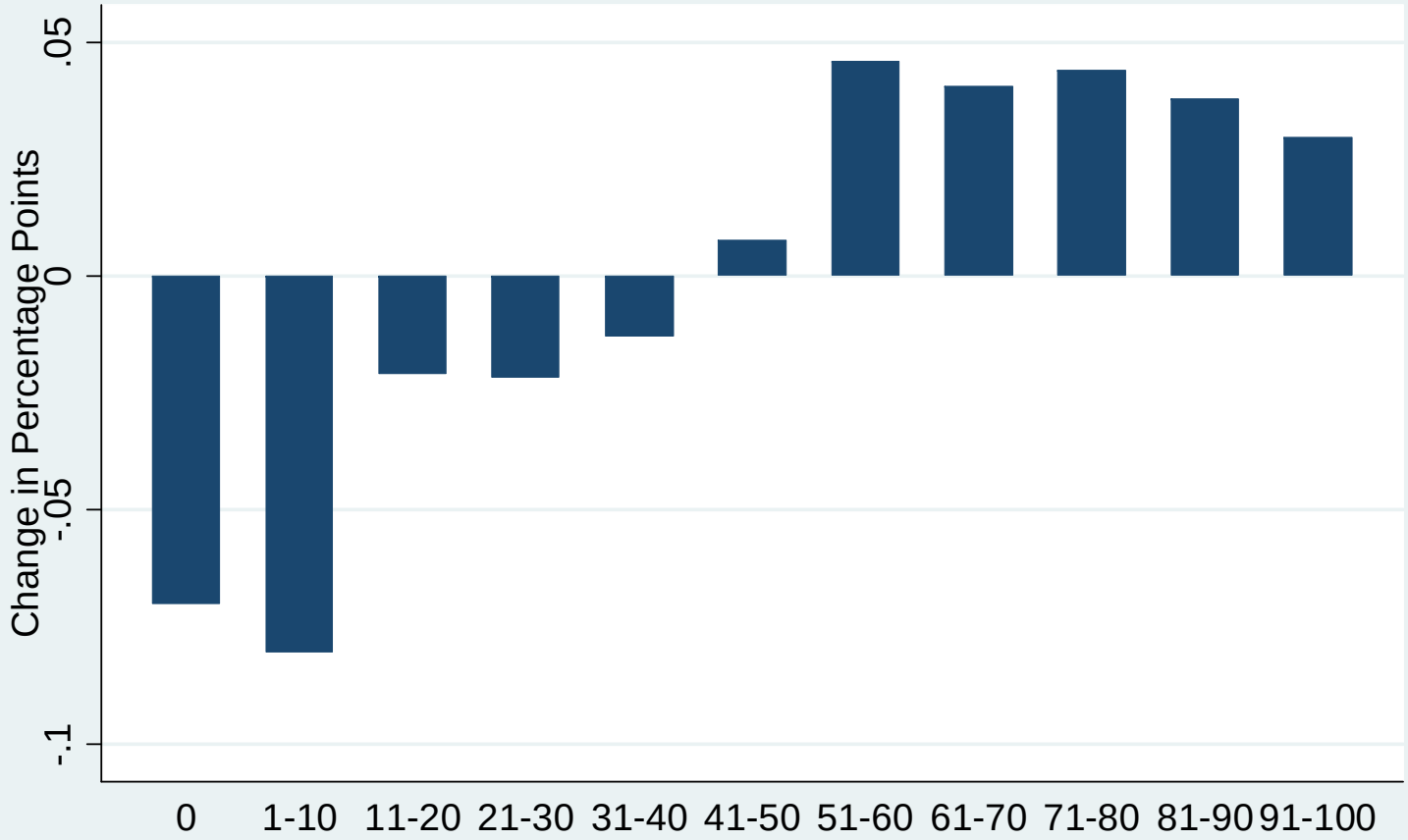
Note: LIAB, Institute for Employment Research.
Proportions are weighted by inverse drawing probabilities.

Distribution of Export Share - Plant Data

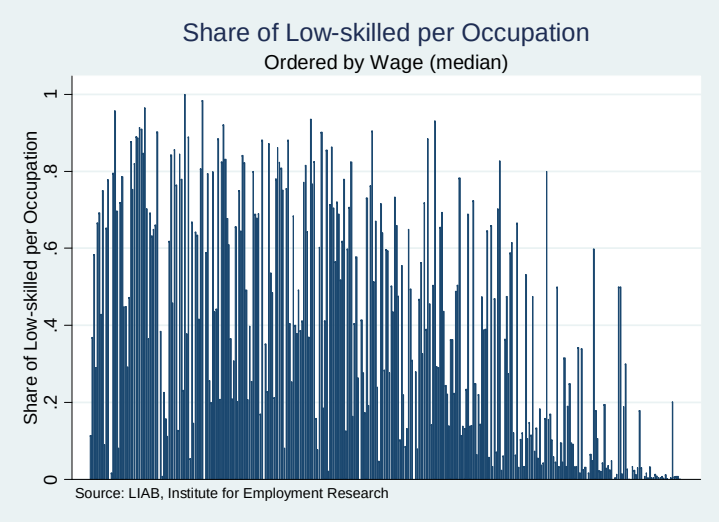


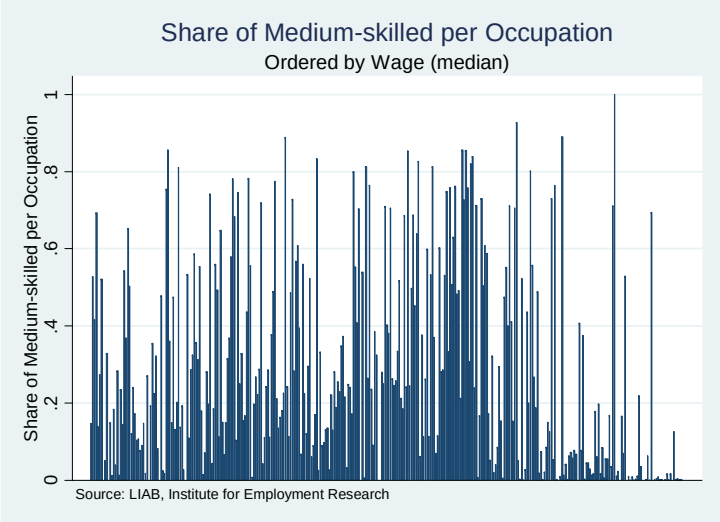
Distribution of Export Share - Employee Data

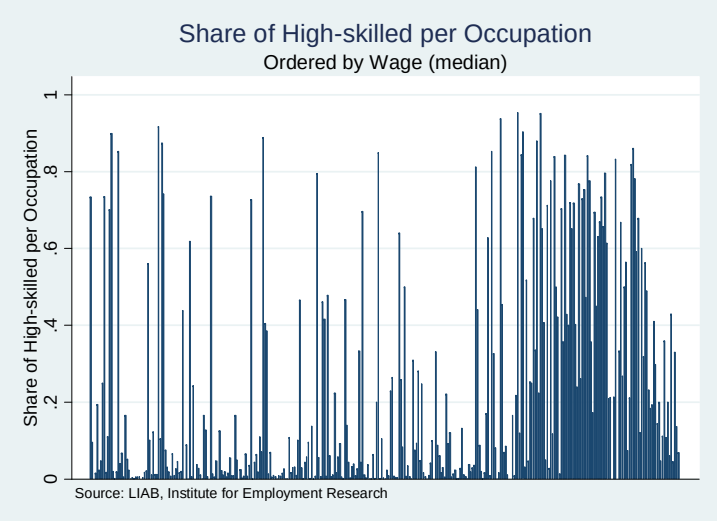
Change in Proportion of Employees by Openness Class from 1993 to 2007

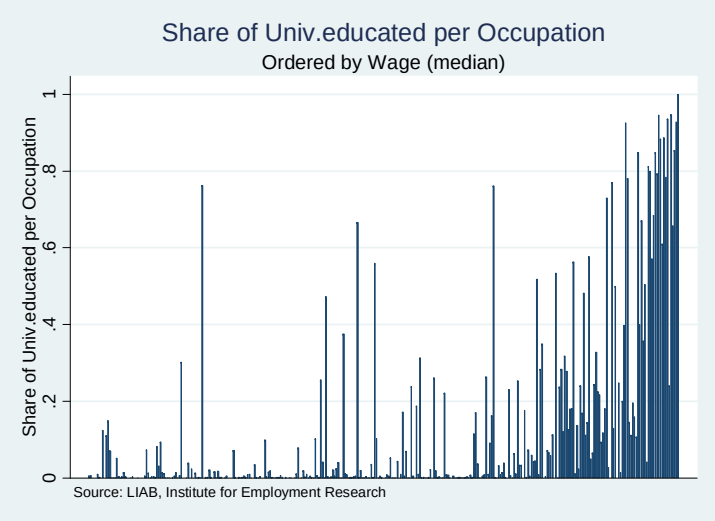


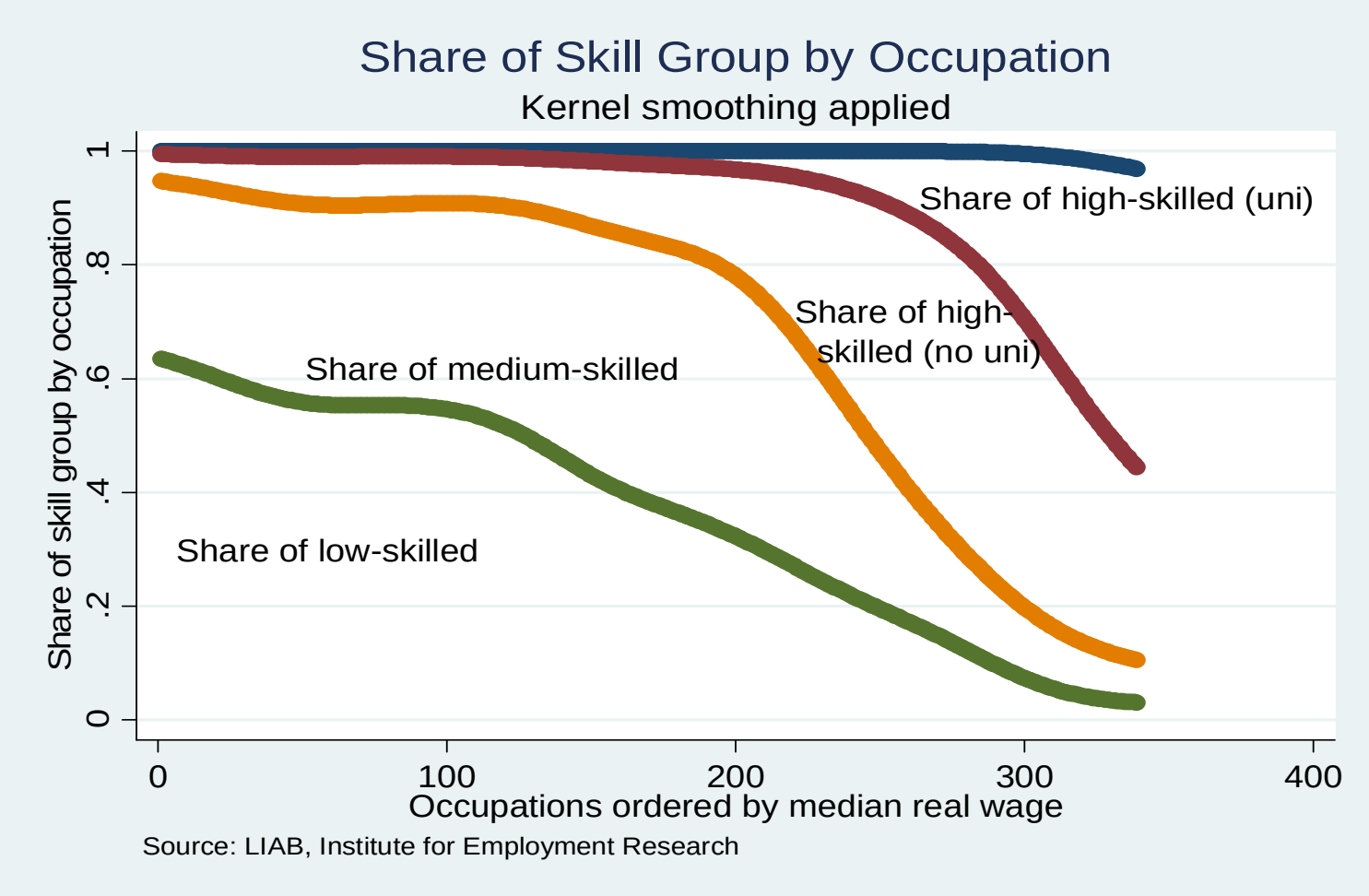
Source: LIAB, Institute for Employment Research.


Share of Low-skilled per Occupation
Ordered by Wage (median)
Share of Low-skilled per Occupation
0
.2
.4
.6
.8
1
Source: LIAB, Institute for Employment Research


Share of Medium-skilled per Occupation
Ordered by Wage (median)
Share of Medium-skilled per Occupation
0
.2
.4
.6
.8
1
Source: LIAB, Institute for Employment Research


Share of High-skilled per Occupation
Ordered by Wage (median)
Share of High-skilled per Occupation
0
.2
.4
.6
.8
1
Source: LIAB, Institute for Employment Research


Share of Univ.educated per Occupation
Ordered by Wage (median)
Share of Univ.educated per Occupation
0
.2
.4
.6
.8
1
Source: LIAB, Institute for Employment Research


Share of Skill Group by Occupation
Kernel smoothing applied
Share of skill group by occupation
0
.2
.4
.6
.8
1
Share of high-skilled (uni)
Share of high-skilled (no uni)
Share of medium-skilled
Share of low-skilled
0
100
200
300
400
Occupations ordered by median real wage
Source: LIAB, Institute for Employment Research

Share of Dominant Type (*Facharbeiter* or *Angestellter*) Across 339 Occupations

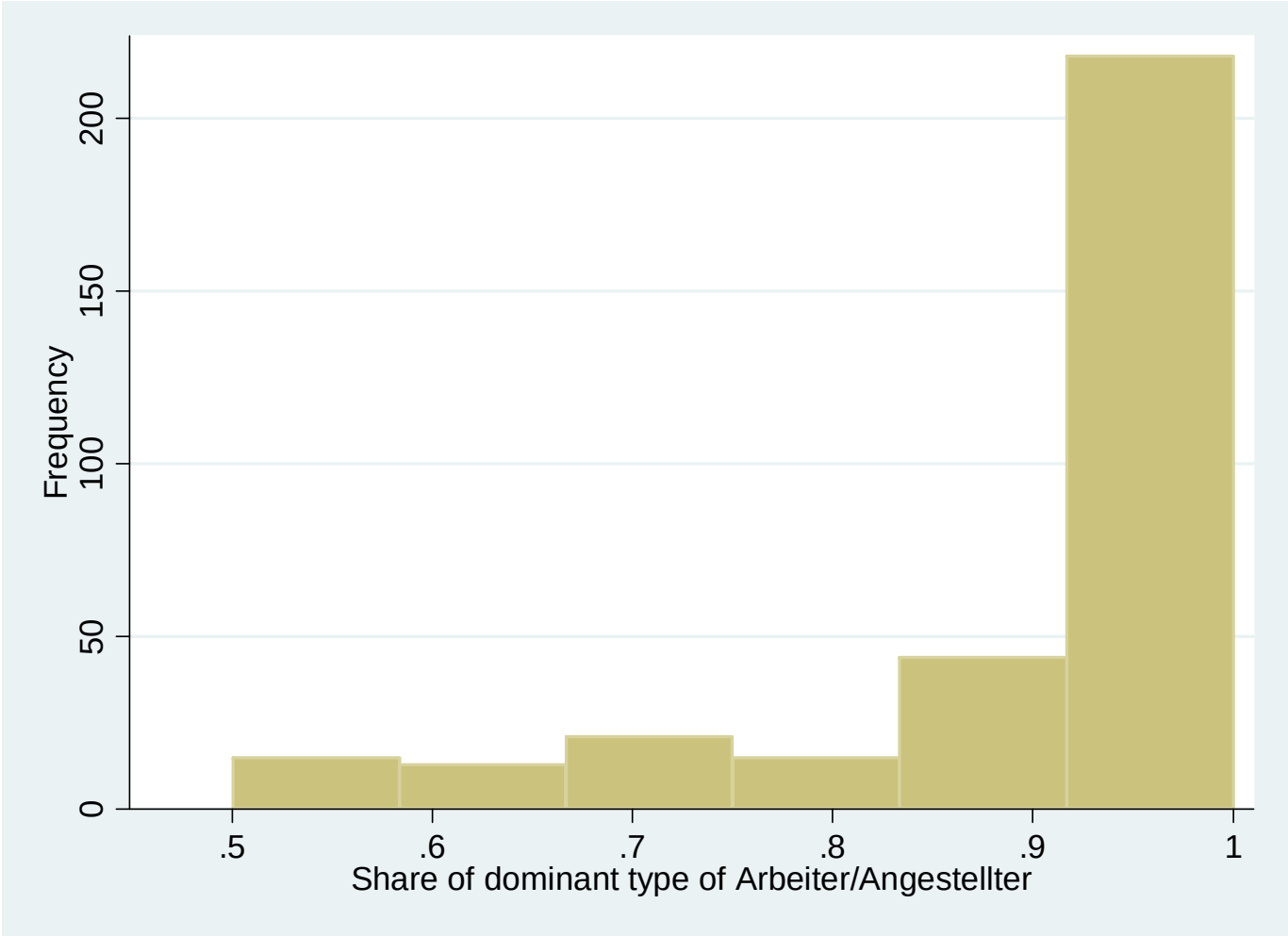


Table 2: Composition of Employees

	All Plants	*Exporters*	*Non-Exporters*
No. Obs. (worker-year)	7,071,930	6,415,790	656,140
Skill Composition			
Low-skilled	0.345	0.368	0.271
Medium-skilled	0.341	0.309	0.446
High-skilled	0.242	0.239	0.247
Univ. Educated	0.072	0.083	0.036
Proportion Women	0.200	0.195	0.215
Proportion Non-Citizen	0.101	0.108	0.081

Source: LIAB, Institute for Employment Research; worker-year observations unweighted.

Table 3: Wage by Worker Categories

	All	*Exporters*	*Non-Exporters*	*Exp – Non.Exp*
All Workers	4.570	4.606	4.453	***0.153***
ln Wages by Skill Level				
Low-skilled	4.374	4.389	4.304	***0.085***
Medium-skilled	4.538	4.574	4.458	***0.116***
High-skilled	4.721	4.787	4.514	***0.273***
Univ. Educated	5.160	5.171	5.078	***0.093***
ln Wages of Women by Skill Level				
Low-skilled	4.178	4.198	4.074	***0.124***
Medium-skilled	4.155	4.194	4.109	***0.085***
High-skilled	4.407	4.514	4.179	***0.335***
Univ. Educated	4.838	4.843	4.803	***0.040***
ln Wages of Non-German Citizens by Skill Level				
Low-skilled	4.386	4.400	4.312	***0.088***
Medium-skilled	4.520	4.566	4.402	***0.164***
High-skilled	4.721	4.774	4.499	***0.275***
Univ. Educated	5.100	5.117	4.920	***0.197***

Source: LIAB, Institute for Employment Research, logarithm of wage in 2005 constant Euros.

Overall Export Wage Premium (eq. 1)

$$\ln W_{i,j,t} = \beta X_{j,t} + \sum_{Z=2}^{4} \alpha_Z S_{i \in Z,t} + \Psi I_{i,t} + \Omega P_{j,t} + \tau_t + F_{i,j,t} + \varepsilon_{i,j,t}$$

- $W_{i,j,t}$ = log wage of worker *i* employed at plant *j* in year *t*.
- $X_{j,t}$ = share of exports at plant *j* in year *t*.
- $S_{i \in Z,t}$ = 1 if worker *i* has skill level *Z*, else 0.
  - *Z* = 1 for low skill, 2 for medium skill, 3 for high skill, and 4 for college or university degree.
  - Omitted dummy is *z* = 1, the low-skill dummy.
- $I_{i,t}$ = characteristics of worker *i* in year *t* other than skill.
- $P_{j,t}$ = characteristics of the plant *j*, where *i* works.
- Fixed effects year in all specifications.
- Other fixed effects: plant, plant-occupation and plant-individual.
- Main coefficient of interest is β.

Overall Export Wage Premium

- How do our estimates relate to the literature (not shown)?
- Our coefficient is 0.035 when no fixed effects are included (OLS), which yields an export wage premium of 1.7 percent at the median value of export share of 0.5.
- Substantially smaller than results based on plant-level observations, which cannot control for individual characteristics.
- But once we only control for logarithm of plant employment and year dummy → coefficient on export share of 0.153 or an export wage premium of nearly 8 percent (median value of exports).

Overall Export Wage Premium

- From here on slides not udpated yet.

Table 4: Effect of Export Share on Wages, Not Differentiating by Skill level

Variable	*OLS*	*P*	*P×O*	*P×I*
Export Share (j)	0.064**	0.018**	0.018**	0.016*
(s.e.)	(0.010)	(0.007)	(0.007)	(0.007)
Medium Skill (i)	0.133**	0.118**	0.063**	0.019**
(s.e.)	(0.004)	(0.003)	(0.003)	(0.005)
High Skill (i)	0.387**	0.367**	0.197**	0.104**
(s.e.)	(0.005)	(0.004)	(0.005)	(0.006)
College/ Univ. Educ. (i)	0.752**	0.706**	0.398**	0.256**
(s.e.)	(0.006)	(0.005)	(0.007)	(0.018)
Woman (i)	-0.328**	-0.287**	-0.215**	–
(s.e.)	(0.006)	(0.004)	(0.003)	–
Non-German (i)	-0.005	-0.022**	-0.008**	0.003
(s.e.)	(0.004)	(0.002)	(0.001)	(0.004)
R^2	0.57	0.67	0.77	0.93
No. of Observations	8,041,676	8,041,676	8,041,676	8,041,676

† = sig. at 90% to 95% level of confidence
* = sig. at 95% to 99% level of confidence.
** = significant at ≥ 99% level of confidence
Fixed Effects year in all specifications. Other fixed effects include plant (*P*), plant-occupation (*P×O*), and plant-individual (*P×I*).

CONTINUED NEXT SLIDE

Table 4: Effect of Export Share on Wages, Not Differentiating by Skill level (cont.)

Variable	*OLS*	*P*	*P×O*	*P×I*
ln(Tenure) (i)	0.025**	0.037**	0.036**	0.016**
(s.e.)	(0.002)	(0.001)	(0.001)	(0.002)
ln(Experience) (i)	0.085**	0.072**	0.062**	0.042**
(s.e.)	(0.002)	(0.001)	(0.001)	(0.002)
ln(Plant employ.) (j)	0.045**	0.009	0.016*	0.046**
(s.e.)	(0.002)	(0.007)	(0.007)	(0.007)
Single Plant Co. (j)	-0.008	-0.001	-0.001	-0.000
(s.e.)	(0.006)	(0.002)	(0.002)	(0.003)
In a Holding Co. (j)	0.033**	0.001	0.001	0.003
(s.e.)	(0.006)	(0.003)	(0.003)	(0.004)
Work Council (j)	0.075**	0.005	0.003	0.005
(s.e.)	(0.008)	(0.005)	(0.006)	(0.006)
R^2	0.57	0.67	0.77	0.93
No. of Observations	8,041,676	8,041,676	8,041,676	8,041,676

† = sig. at 90% to 95% level of confidence
* = sig. at 95% to 99% level of confidence.
** = significant at ≥ 99% level of confidence
Fixed Effects year in all specifications.
Other fixed effects include plant (*P*), plant-occupation (*P×O*), and plant-individual (*P×I*).

Table 6: Estimates of Export Wage Premia

I. Export Wage Premia (percent)

$$\beta_Z \times X_i \times 100\%$$

Skill Category	Export Share		
	25th Percentile	50th Percentile	75th Percentile
Low-skilled	-0.63**	-1.05**	-1.40**
Medium-skilled	-0.15	-0.25	-0.33
High-skilled	1.56**	2.60**	3.40**
Univ. Educated	3.24**	5.40**	7.02**

II. Percent of Wage Premium Due to Export Wage Premium

$$\left[(\beta_Z \times X_i) \Big/ (\alpha_Z + (\beta_Z \times X_i)) \right] \times 100\%$$

Skill Category	Export Share		
	25th Percentile	50th Percentile	75th Percentile
Medium-skilled	-10.9	-19.7	-27.2
High-skilled	16.2**	24.4**	29.6**
Univ. Educated	13.3**	20.4**	25.0**

Calculations based on estimates for plant-individual fixed effects regressions in Table 5; standard errors available on request.

CONTINUED NEXT SLIDE

Table 6: Estimates of Export Wage Premiums (cont.)

III. Differences in Export Wage Premia by Export Share Values – Export-induced Skill Premia $\left(\left[\beta_{Z'} - \beta_Z\right] \times X_i\right) \times 100\%$

	$\beta_{Medium} - \beta_Z$			$\beta_{High} - \beta_Z$			$\beta_{Univ.} - \beta_Z$		
Percentile	25th	50th	75th	25th	50th	75th	25th	50th	75th
Low-skilled	0.48*	0.80*	1.03*	2.19**	3.64**	4.75**	3.86**	6.43**	8.36**
Medium-skilled				1.71**	2.86**	3.71**	3.38**	5.64**	7.33**
High-skilled							1.67†	2.78†	3.61†

IV. Proportion of Overall Skill Premia Due to Export-induced Skill Premia

$$\left[\left(\left[\beta_{Z'} - \beta_Z\right] \times X_i\right) \Big/ \left(\left[\alpha_{Z'} - \alpha_Z\right] + \left(\left[\beta_{Z'} - \beta_Z\right] \times X_i\right)\right)\right] \times 100\%$$

Percentile	25th	50th	75th	25th	50th	75th	25th	50th	75th
Medium-skilled				20.6**	30.2**	36.0**	14.8**	22.4**	27.3**
High-skilled							11.4†	17.7*	21.8*
Univ. Educated									

Calculations based on estimates for plant-individual fixed effects regressions in Table 5, standard errors available on request.

CONTINUED NEXT SLIDE

Table 6: Estimates of Export Wage Premiums (cont.)

V. Differences in Export Wage Premiums with Increasing Export Share Values

$$\left(\beta_{Z'} - \beta_{Z}\right)\left(X_{75th} - X_{25th}\right)\times 100\%$$

	$\beta_{Medium} - \beta_{Z}$	$\beta_{High} - \beta_{Z}$	$\beta_{Univ.} - \beta_{Z}$
	$75^{th} - 25^{th}$	$75^{th} - 25^{th}$	$75^{th} - 25^{th}$
Low-Skilled	0.56*	2.56**	4.50**
Medium-Skilled		2.00**	3.94**
High-Skilled			1.94†

Calculations based on estimates for plant-individual fixed effects regressions in Table 5, standard errors available on request.

Literature Review (I)

- ***Export Wage Premium - Plant-level data:***
  - United States (Bernard and Jensen, 1995, 1999, 2004), Germany (Bernard and Wagner, 1997; Arnold and Hussinger, 2005; Schank, Schnabel and Wagner, 2007), Korea (Hahn, 2004), Spain (Farinas and Martin-Marcos, 2003), Sweden (Hansson and Lundin, 2004) and the United Kingdom (Greenaway and Yu, 2004).
- ***Export Wage Premium - Linked employer-employee data:***
  - Germany *(*Schank, Schnabel and Wagner, 2007, 2010), Denmark (Munch and Skaksen, 2008), Mexico (Frias, Kaplan and Verhoogen, 2009) and Portugal (Martins and Opromella, 2009).

Literature Review (II)

- ***Trade Theory and Wage Inequality:***
  - Melitz (2003), Felbermayr, Prat and Schmerer (2008), Helpman, Itskhoki and Redding (2007, 2008, 2009).
- ***Wage Discrimination:***
  - Becker (1957), Black and Strahan (2001), Black and Brainerd (2004), Weichselbaumer and Winter-Ebner (2007), Oostendorp (2009).
- ***Empirical Strategy:***
  - Abowd, Kramarz and Margolis (1999), Andrews, Schank and Upward (2006).