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The Skill Structure of the Export Wage Premium: Evidence from German Manufacturing

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Abstract: We find a significant export wage premium for higher-skilled workers, and a significant export wage discount for lower-skilled workers, using a matched employer-employee data set for German manufacturing firms. These results imply that increasing trade contributes to widening wage inequality by skill level in manufacturing. But an increase in exports also diminishes wage gaps due to gender or nationality. In this way, trade contributes to narrowing wage gaps in German manufacturing.

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1. Introduction

Manufacturing plants that export differ from those that do not along a variety of dimensions; they are larger, more productive, more capital intensive, and, of particular interest, pay higher wages. In an influential analysis of United States manufacturing plants, Bernard and Jensen (1995) found a wage premium of between 7 and 11 percent in exporting plants, controlling for a number of observable plant-level characteristics. Subsequent work by these authors (1997, 1999) has confirmed the exporter wage premium in the United States, while others have found evidence of an exporter wage premium in other industrial countries, including Denmark (Munch and Skaksen 2008), Germany (Bernard and Wagner 1997 who study the German länder of Lower Saxony, as well as Arnold and Hussinger 2005, and Schank, Schnabel and Wagner 2008), Korea (Hahn 2004), Spain (Farinas and Martin-Marcos 2003), Sweden (Hansson and Lundin 2004), and the United Kingdom (Greenaway and Yu 2004).[1]

A key source of the interest in the wage differential between exporters and other firms is that this could contribute to rising inequality in industrial countries (Krugman 2008, Helpman, Itskhoki and Redding 2009). Bernard and Jensen (1997) argue that much of the rise in wage inequality in United States manufacturing in the 1980s can be accounted for by an increase in relative labor demand by exporters, who, compared to non-exporting firms, employ relatively more highly skilled, non-production-line workers as compared to lower skilled production-line workers.[2] This argument turns on the

[1] Schank, Schnabel and Wagner (2007) survey these results.
[2] Blum (2008) argues that trade played a role in rising United States wage inequality in the 1970s, but not subsequently.

difference in the demand for skilled labor between exporting plants and those that do not export, rather than differences in the exporter wage premiums across skill levels.[3]

These distributional effects are magnified if the export wage premium is more pronounced for higher-skilled workers than for lower-skilled workers. For example, the Bernard and Jensen (1997) inequality effect that occurs through an expansion of the export sector is bolstered by an export wage premium for high-skilled workers that exceeds that of their lower skilled co-workers. There are theoretical reasons to believe that this might, in fact, be the case (Helpman, Itskhoki and Redding 2009). Thus, an investigation of the skill structure of the export wage premium has potentially important implications for the distributional effects of trade.

Most existing studies cannot speak to the skill structure of the exporter wage premium, however, because of data limitations. Studies using plant-level data can, at best, differentiate production-line workers from non-production-line workers. Some of these studies find positive and significant wage premiums for both non-production-line workers and production-line workers (e.g. Bernard and Jensen 1995, 1999, 2004, Hahn 2004, Hansson and Lundin 2004 for 1990 observations), while others find a premium for non-production-line workers only (e.g. Bernard and Wagner 1997, and Hansson and Lundin (2004) for 1999 observations). Other, more recent, analyses use linked employer-employee data sets. Munch and Skaksen (2008) use a Danish matched worker-firm longitudinal data set and find that wages are higher in firms with high export intensity and highly educated workers, but lower in high-export-intensity firms with workers who have lower levels of education. Schank, Schnabel and Wagner (2007) use the German

[3] Bernard and Jensen (1995) find that both production-line workers and non-production-line workers enjoy a wage premium in plants that export as compared to those that do not export.

LIAB data set which links employee statistics to the IAB Establishment Panel to estimate separate regressions for blue-collar and white-collar workers while controlling for a host of individual characteristics including age, gender, level of education, and nationality. They present evidence of higher export wage premium for blue collar workers than for white collar workers.

In this paper, we investigate the skill structure of the wage premiums (or discounts) over the period 1993 – 2007 for workers employed by western German manufacturing plants that export, using the linked employer-employee LIAB data set. This panel data set provides us with information that enables us to characterize both workers and plants at a level of detail that contributes importantly to the analysis. The data enables us to construct four skill categories for workers by using information on their educational attainment, their occupation, and the manner in which they are classified by the German social security system. We find that there is a significant export wage premium for workers in the two highest skill categories, and evidence of an export wage discount for lower-skilled workers. These results are confirmed when estimating the export wage premium across the 339 occupations defined in the data set rather than the four skill categories we have constructed. The export wage premium for higher-skilled workers combined with the wage discount for lower-skilled workers implies an increase in manufacturing wage disparities with an expansion in the number of plants that export, or with an increase in the share of exports relative to total manufacturing output.

But while an expansion in exporting may widen inequality across skill levels, another set of results presented in this paper shows that an increase in exports diminishes manufacturing wage gaps due to gender or nationality. Higher-skilled women, who are paid less than men with comparable personal characteristics in comparable plants, enjoy a higher export wage premium than men, and there is no evidence of an export wage discount (or premium) for medium-skilled and lower-skilled women. Likewise, higher-skilled manufacturing workers who are not German citizens enjoy an export wage premium and there is not a significant export wage discount for these workers either. Thus, exporting firms exhibit less wage discrimination than non-exporting firms, perhaps because they face stiffer competition (which would be consistent with Becker 1957). Thus, while an increase in the average export share of the German economy raises wage inequality along the dimension of skill, it lowers wage inequality along the dimensions of gender and citizenship.

The next section of this proposal presents our initial estimates of differences in the export wage premium across skill groups. Section 3 then extends this analysis to show how the export wage premium differs between men and women. Section 4 offers some concluding comments.

2. The Skill Structure of the Export Wage Premium

In many models of international trade, exporters are distinguished from non-exporters because they have higher levels of exogenous productivity (e.g. Dornbusch, Fischer and Samuelson 1977, Melitz 2003). Models that seek to explain differences in wages between exporting and non-exporting firms must also offer reasons for a lack of full labor mobility between exporting and non-exporting firms, and reasons why exporting (i.e. higher productivity) firms pay higher wages. For example, in the model of Helpman, Itskhoki and Redding (2009), an export wage premium arises because of increasing returns, costly verification of workers' skills, and strategic bargaining between workers and firm owners. Extensions of their basic model to include differences in technologies across firms, or complementarities between capital and labor, can result in different export wage premium for workers in different occupations within a firm. The various versions of this model demonstrate how an expansion of trade affects overall inequality through both changes in within-occupation inequality (which rises with a move from autarky to trade) and between-occupation inequality (which may rise or fall). Alternatively, Verhoogen (2008) describes how an expansion in the production of higher quality goods, in response to an exogenous increase in the incentive to export, can lead to an increased demand for higher quality employees within each worker category, and an increase in the export wage premium that contributes to widening within-category inequality. He presents evidence of the operation of this effect in Mexico in the wake of its 1994 devaluation.

We present some of our initial evidence on the export wage premium, and how it differs across skill groups and gender, using a matched employee-employer dataset on German workers and establishments with data for the period 1993 – 2007. The regression specification estimates export wage premium for each of four skill groups (low-skilled workers, medium-skilled workers; high-skilled workers, and workers with college or university degrees) by interacting the export share of sales for each firm with each worker's skill category. The skill category for a particular individual is determined with reference to his or her occupation, educational attainment, and identification as a member of the lower-skilled category of *Facharbeiter* or the higher-skilled category of *Angestellter* by the German social security system. *Facharbeiter* includes unskilled, blue-collar workers who might have some vocational training. *Angestellter* includes master craftsmen and white-collar workers.[4] Table 1 summarizes the classification scheme, and shows the weighted proportion of each group in the sample.[5]

Table 1: Skill Levels by Education / Occupation

Education	Occupation Classification (*Prop. Of Sample*)	
	Facharbeiter	*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*	College/Univ. Educated (*0.07*)

Source: LIAB, Institute for Employment Research.

The use of four skill categories, rather than the 339 occupations identified in the data set, allows for tractable interaction with export status. The four skill categories also provide a more accurate indicator of workplace skill level than one based solely on educational attainment, or one that only distinguishes between production and non-production workers, a distinction typically used in studies based on plant-level data. The specification we use is

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

where the dependent variable is the logarithm of $W_{i,j,t}$, which is the average daily gross wage of worker *i* who is employed at plant *j* in year *t*. The share of exports in total

[4] There is a high correspondence between a worker's occupation and whether he or she is classified as a *Facharbeiter* or an *Angestellter*. For example, more than 90 percent of the workers in more than 200 of the 336 occupations are classified as either *Facharbeiter* or an *Angestellter*. In contrast, fewer than 20 occupations have no more than two-thirds of their workers in either the *Facharbeiter* or an *Angestellter* category. Thus, the *Facharbeiter* / *Angestellter* distinction is largely, though not exclusively, a categorization by occupational category.

[5] Weights are based on survey drawing probabilities since small establishments are less likely to be sampled than larger establishments.

revenue of plant j in year t is $X_{j,t}$. For firms that export (that is, those for which $X_{j,t} > 0$), the 25th, 50th, and 75th percentile values of $X_{j,t}$ are 0.30, 0.50, and 0.65, respectively. An individual's skill level is captured by the dummy variables in the four element vector $S_{i \in Z,t}$, where $Z = 1$ for low skill, 2 for medium skill, 3 for high skill, and 4 for college or university degree. Thus, the four estimated skill-specific export wage premiums in this equation are β_L, β_M, β_H and β_U.[6] The three skill coefficients, α_M, α_H and α_U, represent the skill premiums relative to the low-skilled group that are not associated with exporting (low skilled workers in plants that do not export is the omitted category). Other individual characteristics are represented by the vector $I_{j,t}$ and include the logarithm of experience, the logarithm of tenure, and dummy variables for gender and German citizenship.[7] Plant-level characteristics other than export share, represented by the vector $P_{j,t}$, include the logarithm of number of employees as well as characteristics of particular relevance for German industries and for the German labor market.[8] Time fixed effects are represented by τ_t. The regression specification includes other fixed effects as well, as represented by $F_{i,j,t}$, which are: Plant fixed effects (denoted P in the Table 2) that control for unobserved, non-time-varying differences in exporting plants as compared to

[6] Schank, Schnabel and Wagner (2007) take a different approach and estimate separate regressions for each of their two categories of workers.

[7] Experience is measured as the number of days since the worker's entry into employment, and tenure is measured as the number of days since the worker's entry into his or her current position.

[8] One of the variables in the vector $P_{j,t}$ is the logarithm of the share of workers in a plant who have fixed-term contracts of one or two years and, therefore, are not governed by the same rules as regular full-time workers (we do not have employee-level data on whether individuals are on fixed-term contracts or regular contracts). This vector also includes a number of dummy variables. One indicates the presence of a work council at a plant; workers at plants with more than 20 employees have the right to establish a work council to represent their interests, although they are not obliged to do so. Two other dummy variables indicate whether workers in the plant are part of a collective bargaining agreement at the plant level, or at the industry level. We also include a dummy variable indicating whether a plant represents the entire company (Single Plant Company), and another indicating whether the plant belongs to a Holding Company – thus, the omitted category is a headquarter plant in a multi-plant company. In addition, some regressions also include a dummy variable that equals 1 if managers self-assess their plant as operating at the technological frontier for its industry.

non-exporting plants but do not control for time-varying differences in occupational composition between exporting plants and other plants; or Plant-Occupation fixed effects (denoted $P \times O$) which allows for the possibility that occupations affect wages differently across plants; or Plant-Individual fixed effects (denoted $P \times I$) which controls for unobserved individual-level characteristics combined with plant-level dummy variables to control for the possibility that an individual's productivity differs across plants.[9]

Estimates of the coefficients β_L, β_M, β_H and β_U, as well as α_M, α_H and α_U, are reported in Table 2. The three panels of this table correspond to estimates using the plant (P), plant-occupation ($P \times O$), and plant-individual ($P \times I$) fixed effects, respectively. In addition, the table includes tests of the pair-wise differences among all four export wage premium coefficients. These are presented as the difference of the higher-skilled category minus the lower-skilled category, so a positive value indicates an increasing wage gap with an expansion of exports.

Results presented in Table 2 show that, with each of the three fixed effects specifications, each of the three α coefficients are significant at better than the 99 percent level of confidence, with values rising with skill level. Three of the four β coefficients are significant with each fixed effects specification at better than the 99 percent level of confidence, with β_H and β_U significant and positive in all three cases, β_M significant and negative with plant fixed effects and plant-occupation fixed effects, and β_L significant and

[9] We find higher estimated export wage premiums when we do not control for unobserved, time-invariant establishment-level effects since unobserved differences across establishments are associated with both higher productivity and a propensity to export. Plant-individual fixed effects do not control for time-varying returns to skills, but Frías, Kaplan and Verhoogen (2009) suggest that this may not be empirically important.

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

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	—	-0.015	-0.053**	0.138**	0.147**
(s.e.)	—	(0.009)	(0.009)	(0.013)	(0.017)
Medium-skilled	0.133**	-0.068**	—	0.191**	0.200**
(s.e.)	(0.004)	(0.009)	—	(0.014)	(0.018)
High-skilled	0.327**	0.123**	—	—	0.009
(s.e.)	(0.006)	(0.013)	—	—	(0.015)
Univ. Educated	0.651**	0.132**	—	—	—
(s.e.)	(0.009)	(0.018)	—	—	—

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	—	0.007	-0.033**	0.044**	0.094**
(s.e.)	—	(0.008)	(0.009)	(0.019)	(0.012)
Medium-skilled	0.073**	-0.026**	—	0.081**	0.127**
(s.e.)	(0.004)	(0.008)	—	(0.013)	(0.020)
High-skilled	0.185**	0.051**	—	—	0.050**
(s.e.)	(0.007)	(0.011)	—	—	(0.014)
Univ. Educated	0.366**	0.101**	—	—	—
(s.e.)	(0.010)	(0.020)	—	—	—

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	—	-0.021**	0.016*	0.073**	0.129**
(s.e.)	—	(0.008)	(0.007)	(0.013)	(0.037)
Medium-skilled	0.015**	-0.005	—	0.057**	0.113**
(s.e.)	(0.006)	(0.007)	—	(0.011)	(0.037)
High-skilled	0.081**	0.052**	—	—	0.056†
(s.e.)	(0.007)	(0.012)	—	—	(0.029)
Univ. Educated	0.210**	0.108**	—	—	—
(s.e.)	(0.021)	(0.037)	—	—	—

† = sig. at 90% to 95% level of confidence
* = sig. at 95% to 99% level of confidence.
** = significant at ≥ 99% level of confidence
See Table 5 for list of other regressors.

negative with plant-individual fixed effects. Also, in all three sets of estimates, $\beta_U > \beta_H$ and both are greater than β_L and β_M, although $\beta_M > \beta_L$ with plant-individual fixed effects only. The right side of each panel shows that five of the six differences between pairs of the β coefficients are significant at better than the 95 percent level of confidence. The linear combination $\beta_U - \beta_H$ is significant at this level of confidence in the plant-occupation fixed effects specification, and the p-value is 0.056 for the estimates using plant-individual fixed effects.[10]

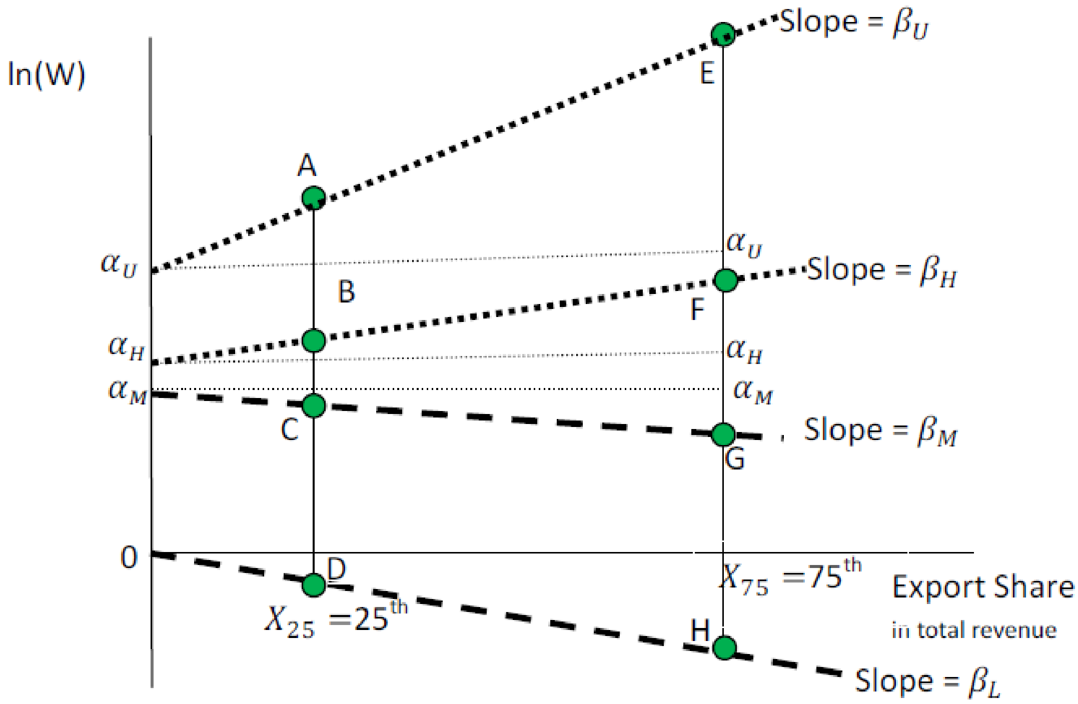
The interpretation of the estimates presented in Table 2 is facilitated by Figure 1 which illustrates the export wage premium for each of the four groups of workers as a function of the export share. The intercept of each line represents the respective α coefficients (with $\alpha_L = 0$ since the low-skill dummy is omitted in this specification). Differences in the values of the intercept show the skill wage premium, relative to low-skilled workers, for firms that do not export. The slope of each line represents the respective semi-elasticity of wages with respect to the export share in total revenue, that is,

$$\left.\frac{\partial \ln W_{i,j,t}}{\partial X_{j,t}}\right|_Z \text{ where } Z = L, M, H, \text{ or } U.$$

These semi-elasticities may be positive or negative. As drawn, the figure presents an export wage discount, rather than an export wage premium, for medium skilled workers

[10] The results in this table are robust to the inclusion of an indicator of technological sophistication, which is a dummy variable that takes the value 1 if a firm's managers reported that the firm operated at or near the technological frontier of the industry. Regressions were augmented with a set of eight variables that included a self-reported indicator of technological sophistication interacted with both skill level, and with skill level and export share. The inclusion of this variable reduced the sample size by about 10 percent, to 7,342,401. The coefficients on the interactions of skill level and export status changed very little, and the pattern of significance was unaltered with the inclusion of these additional variables. This supports the conclusion that results in Table 2 are not merely reflecting higher levels of technological sophistication among exporting firms as compared to non-exporting firms.

Figure 1: Interpretation of Regression Coefficients



and low skilled workers, which is consistent with the statistically significant estimates in Table 2.

Table 3 includes five sets of relevant results that can be calculated from the estimates in Table 2.[11] Panel I presents the export wage premium at various values of the export share. This is represented in Figure 1 as, for example, the vertical distance between the point E and the line denoted α_U representing the wage premium for university-trained workers in a plant that is in the 75th percentile of the export share distribution. The value associated with this based on the regression estimates is $\beta_U \times X_{75th}$.

Panel I of Table 3 shows that the export wage premium is negative for low-skilled and medium-skilled workers (although it is not statistically significant for medium-skilled workers – the statistical significance of the results in Panel I depend upon the statistical significance of each of the four respective β coefficients). The estimated export wage premiums are positive for high-skilled and university-educated workers. The export wage premiums for university-educated workers, which range from 3.24 percent for workers in firms at the 25th percentile of export share to 7.02 percent for workers in firms at the 75th percentile of export share, are more than double that of high-skilled workers at respective percentiles of export share.

Panel II of Table 3 reports the proportion of the overall wage premium for a given skill group that is due to the export wage premium at the 25th, 50th, and 75th percentile

[11] These estimates are based on the plant-individual fixed effects results in Table 2.

Table 6: Estimates of Export Wage Premiums

I. Export Wage Premiums (percent)

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

Skill Category	Export Share		
	25th Percentile	50th Percentile	75th Percentile
Low-Skilled	-0.63**	-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**

III. Differences in Export Wage Premiums by Export Share Values

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

	$\beta_{Medium} - \beta_Z$			$\beta_{High} - \beta_Z$			$\beta_{Univ.} - \beta_Z$		
Percentile	25th	50th	75th	25th	50th	75th	25th	50th	75th
Low-Skilled	0.5*	0.8*	1.0*	2.2**	3.6**	4.8**	3.9**	6.4**	8.4**
Medium-Skilled				1.7**	2.9**	3.7**	3.4**	5.6**	7.3**
High-Skilled							1.7†	2.8†	3.6†

IV. Proportion of Differences in Wage Premiums due to Export Wage Premium

$([\beta_{Z'} - \beta_Z] \times X_i) \big/ ([\alpha_{Z'} - \alpha_Z] - ([\beta_{Z'} - \beta_Z] \times X_i))$

				High − Z			Univ. − Z		
Percentile	25th	50th	75th	25th	50th	75th	25th	50th	75th
Medium-Skilled				21**	30**	36**	15**	22**	27**
High-Skilled							11†	18*	22*

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

$(\beta_{Z'} - \beta_Z)(X_{75th} - X_{25th})$

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

Note: Calculations based on estimates for plant-individual fixed effects regressions in Table 5, standard errors are available from the authors upon request.

values of export share.[12] As an example of this from Figure 1, consider the export wage premium relative to the overall wage premium for university-trained workers in the 75th percentile of export shares. This is represented by the vertical distance between the point E and the line denoted α_U relative to the vertical distance from the horizontal axis to point E. In terms of the terms of the regression coefficients, this is

$$(\beta_U \times X_{75th}) \Big/ (\alpha_U + (\beta_U \times X_{75th})).$$

The statistics presented in Panel II show that the export wage premium is an important component of the overall wage premium. For example, it is a fifth of the wage premium for university-educated workers in firms at the 50th percentile of export share, and one-quarter for workers in firms at the 75th percentile of export share. The comparable values for high-skilled workers are 24.3 percent and 29.4 percent. The export wage premium mitigates the overall premium for medium-skillled workers, reducing it by up to 27.7 percent for workers in firms at the 75th percentile of export share.

The calculations in the first two panels of Table 3 reflect wage premiums relative to low-skilled workers at firms that do not export. Panels III, IV, and V offer pairwise differences across all four categories of workers at firms with comparable levels of exports. Panel III presents the pairwise differences in export premiums at the 25th, 50th, and 75th percentile values of export share.[13] These can be illustrated by considering

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[12] These premiums are relative to low-skilled workers at firms that do not export. Thus, the only premium for low skilled workers is through the export wage premium and, for that reason, the export wage premium represents 100 percent of their wage premium – for this reason, calculations for low-skilled workers are not included in this panel.

[13] The statistics in this table are export wage premiums of workers of one skill-level versus another where both skill levels are at a plant with a common export share. Thus, the export wage premium relative to low skilled workers exceeds that in Panel I since those statistics are for low-skilled workers in a plant that does not export and there is a negative export wage premium for low-skilled workers.

Figure 1 where, for example, the difference in the export wage premium for university-trained workers as compared to medium-skilled workers at the 75th percentile of export share is $((E - \alpha_U) - (G - \alpha_M))$. The corresponding value from the regression coefficients is $([\beta_U - \beta_M] \times X_{75th})$. The results in this panel exhibit substantial premiums within plants at the same skill level. For example, the export wage premium of university-educated workers relative to low-skilled workers, medium-skilled workers, and high-skilled workers at a plant at the 75th percentile of export share is 8.39 percent, 7.3 percent, and 3.6 percent, respectively, and high-skilled workers have a premium of 4.75 percent over low-skilled workers and 3.7 percent over medium-skilled workers.

Panel IV shows that the values in Panel III represent substantial proportions of the overall pair-wise wage premiums. The results in this panel are comparable to those in Panel II, although there the comparison group is exclusively low-skilled workers in firms that do not export and, in Panel IV, comparisons are made across skill groups in plants with a common level of export share. For example, a representative statistics in Panel IV is that of high-skill workers as compared to medium-skill workers at the 75th percentile of export share. The difference in the export wage premium, relative to the difference in the overall wage premium, for this pair is

$$([\beta_U - \beta_M] \times X_{75th}) \Big/ ([\alpha_U - \alpha_M] - ([\beta_U - \beta_M] \times X_{75th})).$$

As shown in this panel, the differences in the export wage premium represent a substantial proportion of the pair-wise differences in the overall wage premiums. At the median value of export share, the export wage premium represents about one-third of the overall premium of medium-skilled workers and high-skilled workers relative to low-skilled workers, and almost one-quarter of the overall premium of university-educated workers to low-skilled workers.

The final panel of Table 3 shows how a change in export share affects the wage gap between workers at two different skill levels. These statistics represent the percentage point change in differences in wages due to a change in the export share from the 25th percentile level to the 75th percentile level. As shown in Panel V, a change of this magnitude increases the difference between university-educated workers and low-skilled workers by 4.5 percentage points, and between medium-skilled workers and low-skilled workers by 4.0 percentage points. The effects are smaller for the difference in wages between high-skilled workers and medium-skilled workers (2.0 percentage points) or low-skilled workers (2.6 percentage points). Each of the estimates in Panel V are statistically significant at better than the 95 percent level of confidence but for that between high-skilled and university-educated workers, which is significant at better than the 90 percent level of confidence.

The results in Table 3 show that differences in the export wage premium represent an important proportion of the overall difference in wages across skill levels. The manner in which the export wage premium increases with the skill level suggests that this contributes to wage inequality across skill groups. But, as will be shown in the next section, exporting firms serve to diminish wage inequality along the dimensions of gender.

3. Gender and Export Wage Premiums

Discrimination is a luxury more difficult to indulge in a competitive environment than in one where firms enjoy greater market power (Becker 1957). For this reason, we may expect to find less wage discrimination in German manufacturing firms that export and face keener competition from abroad than among those firms that are insulated from world markets. In this section we show that women in exporting firms receive higher pay than comparably-skilled women in non-exporting firms. Thus, while exporting firms contribute to wage inequality across skill categories, exporting firms narrow wage gaps across gender.

These conclusions are based on analyses that modify the specification used in the previous section to allow for differences in the overall wage premium, as well as the export wage premium by skill levels, depending upon gender. The specification takes the form

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

where the gender dummy variable, G_i , equals 1 if individual *i* is a women, and all other variables are as described above.[14] The coefficient α_Z^G , which is negative in all estimates, represents the wage shortfall for women of skill level *Z*, conditional on personal characteristics and the characteristics of the non-exporting plants in which they work.

[14] The estimates employ plant-occupation fixed effects. Individual-level fixed effects cannot be used with the inclusion of the immutable person-level characteristic of gender.

Table 4: Export Skill Premium for Women

***P×O*, Plant-Occupation FE**	R^2=0.77	No. obs. = 8,041,676		
Skill Level	*α_Z (Skill)*	*β_Z (Skill×Exp)*	*α_Z (Women)*	*β_Z (Women)*
Low-skilled	—	-0.004	-0.178**	0.057**
(s.e.)	—	(0.009)	(0.005)	(0.011)
Medium-skilled	0.079**	-0.029**	-0.175**	0.037
(s.e.)	(0.004)	(0.008)	(0.012)	(0.028)
High-skilled	0.223**	0.034**	-0.303**	0.043**
(s.e.)	(0.007)	(0.012)	(0.008)	(0.014)
Univ. Educated	0.388**	0.099**	-0.266*	0.013
(s.e.)	(0.011)	(0.020)	(0.011)	(0.021)

Export Wage Premium for Women, by Export Share Percentile			
Skill Level	25^{th} Percentile	50^{th} Percentile	75^{th} Percentile
Low-skilled	0.016**	0.026**	0.034**
(s.e.)	(0.004)	(0.006)	(0.008)
Medium-skilled	0.003	0.004	0.006
(s.e.)	(0.008)	(0.014)	(0.178)
High-skilled	0.023**	0.039**	0.051**
(s.e.)	(0.005)	(0.008)	(0.010)
Univ. Educated	0.033**	0.056**	0.073**
(s.e.)	(0.007)	(0.012)	(0.016)

Note: Other control variables as in Table 5.

The coefficient β_Z^G, which is positive in all cases, represents the extent to which this shortfall is mitigated by working in a plant that exports. The coefficients α_Z, and β_Z represent the skill premium and the export skill premium, respectively, for men.

Results presented in Table 4 report the coefficients α_Z^G, β_Z^G, α_Z, and β_Z, as well as the export wage premiums, $(\beta_Z + \beta_Z^G)X_i$ for X_i representing the 25th, 50th, or 75th percentile values of export share. As shown in the α_Z^G column of the top panel, there is a large shortfall in conditional wages for women in plants that do not export, ranging from 17.5 percent for Medium-skilled workers to 30.3 percent for High-skilled workers. This difference is smaller (though still present) in plants that export. As shown in the second panel, women working in a plant that exports are estimated to have higher wages than those who work in non-exporting plants across all four skill groups, and this difference is statistically significant for Low-skilled, High-skilled, and University-educated women. This contrasts with the wage discounts for low and medium skilled men that is evident from the β_Z column of the top panel. High-skilled women have an export wage premium that is statistically distinct from that of high-skilled men, and more than twice as large (0.077 vs. 0.034).

The conditional wage shortfall faced by women is notably smaller in plants with large export shares than in plants that do not export. The conditional wage shortfall for University-educated women is 27 percent smaller in plants that have an export share in the 75th percentile, and 21 percent smaller in plants with the median export share, as compared to plants that do not export. Comparable statistics for High-skilled women are 17 percent and 13 percent, and for Low-skilled women the statistics are 20 percent and 15 percent. Thus, while exporting plants mitigate, but do not eliminate, gender-based wage discounts across skill levels.

Conclusion

International competition has been long been cited in debates on the sources of rising wage inequality. In this paper, we argue that it is important to consider inequality along several dimensions. Our use of a linked employer-employee data base enables us to examine how wages in exporting plants differ from wages in plants that do not export for workers at different skill levels, as well as for workers who are members of groups that have traditionally been the subjects of discrimination. As with other research, we find evidence of an export wage premium but an important distinction between our research and previous work is that we identify differences in the export wage premium across skill groups. Lower skilled workers in German manufacturing are show to have an export wage discount while higher skilled workers have an export wage premium. This is a source of conditional wage inequality within exporting plants, and exacerbates inequality between exporters and non-exporters. But while the exporting / non-exporting distinction contributes to conditional wage inequality along the dimension of skill, it reduces gender-based and nationality-based conditional wage inequality in ways that are both statistically significant and economically meaningful. Thus, the overall effect of exporting on inequality is somewhat ambiguous; production complementarities contribute to skill-based inequality while stronger competition reduces gender or nationality-based inequality.

References

Arnold, J.M., Hussinger, K. (2005), "Export behavior and firm productivity in German manufacturing. a firm-level analysis," *Review of World Economics / Weltwirtschaftliches Archiv,* Vol. 141, pp. 219–243.

Becker, Gary S. (1957), *The Economics of Discrimination*, 1st Edition, Chicago, University of Chicago Press.

Bernard, A.B., Jensen, J.B. (1995), "Exporters, jobs, and wages in U.S. manufacturing: 1976–1987," *Brookings Papers on Economic Activity. Microeconomics*, pp. 67–119.

Bernard, A.B., Jensen, J.B. (1997), "Exporters, skill upgrading and the wage gap," *Journal of International Economics*, Vol. 42, pp. 3–31.

Bernard, A.B., Jensen, J.B. (1999), "Exceptional exporter performance: cause, effect, or both?" *Journal of International Economics*, Vol. 47, pp. 1–25.

Bernard, A.B., Wagner, J. (1997), "Exports and success in German manufacturing," *Weltwirtschaftliches Archiv / Review of World Economics*, Vol. 133, pp. 134–157.

Black, Sandra E., Brainerd, Elizabeth, "Importing Equality? The Impact of Globalization on Gender Discrimination," *Industrial and Labor Relations Review*, Vol. 57, no. 4, July, pp. 540 – 599.

Dornbusch, Rudiger, Stanley Fischer and Paul A. Samuelson (1977), "Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods," *American Economic Review*, vol. 67, pp. 823 – 839.

Farinas, J.C., Martin-Marcos (2007), "Exporting and economic performance: Firm-level evidence of Spanish manufacturing," *The World Economy*, Vol. 30, pp. 618-646.

Frías, Judith A., David S. Kaplan and Eric Verhoogen (2009), "Exports and Wage Premia: Evidence from Mexican Employer-Employee Data," mimeo, Columbia University, August.

Greenaway, D., Yu, Z. (2004), "Firm-level interactions between exporting and productivity: industry-specific evidence," *Review of World Economics/ Weltwirtschaftliches Archiv*, Vol. 140, pp. 376–392.

Helpman, Elhanan, Oleg Itskhoki, and Stephen Redding, "Inequality and Unemployment in a Global Economy," mimeo, Harvard University, June 2009.

Hahn, C.H. (2004), "Exporting and performance of plants: Evidence from Korean manufacturing," NBER Working Paper Series, Vol. 10208.

Hansson, P., Lundin, N.N. (2004), "Exports as an indicator on or promoter of successful Swedish manufacturing firms in the 1990s," *Review of World Economics / Weltwirtschaftliches Archiv*, Vol. 140, pp. 415–445.

Helpman, Elhanan, Oleg Itskhohi and Stephen Redding, "Inequality and Unemployment in a Global Economy," mimeo, November 6, 2009.

Krugman, P. (2008), "Trade and Wages, Reconsidered," *Brookings Papers on Economic Activity,* Spring, pp. 103-154.

Melitz, Marc J., (2003), "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, vol. 71, pp. 1695 – 1725.

Munch, J.R., Skaksen, J.R. (2008), "Human capital and wages in exporting firms," *Journal of International Economics*, Vol. 75, pp. 363-372.

Schank, T., Schnabel, C., Wagner, J. (2007), "Do exporters really pay higher wages? First evidence from German linked employer–employee data," *Journal of International Economics*, Vol. 72, pp. 52-74.

Verhoogen, Eric (2008), "Trade, Quality Upgrading, and Wage Inequality in the Mexican Manufacturing Sector," *Quarterly Journal of Economics*, vol 123, no. 2, May.