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ABSTRACT

The Levelling Effect of Product Market Competition on Gender Wage Discrimination*

Using linked employer-employee panel data for West Germany that include direct information on the competition faced by plants, we investigate the effect of product market competition on the gender pay gap. Controlling for match fixed effects we find that intensified competition significantly lowers the unexplained gap in plants with neither collective agreements nor a works council. Conversely, there is no effect in plants with these types of worker codetermination, which are unlikely to have enough discretion to adjust wages in the short run. We also document a larger competition effect in plants with few females in their workforces. Our findings are in line with Beckerian taste-based employer wage discrimination that is limited by competitive forces.

JEL Classification: J16, J31, J71

Keywords: gender pay gap, discrimination, product market competition

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1 Introduction

Studies documenting a significant, persistent gender pay gap are legion, as are studies relating this gap to wage discrimination in the labour market.[1] The usual theoretical approach to wage discrimination originates in the pathbreaking work by Becker (1971). According to Becker, discrimination stems from personal prejudices among employers, co-workers, or costumers that constitute discriminatory preferences among these groups. As a case in point, discriminatory employers may suffer a disutility from employing women. To be compensated for the loss in utility following from employing women, these employers pay lower wages to women than to men, *ceteris paribus*. In the non-segregating equilibrium, all female workers receive a lower wage than men, no matter whether they work for an employer with or without discriminatory preferences.

Yet, as pointed out by Arrow (1973), in equilibrium non-discriminatory employers employ more women at below-productivity wages than their discriminatory counterparts and therefore gain a competitive advantage over their competitors. Put differently, indulging discriminatory preferences comes at a cost in this framework. Indeed, empirical studies have documented that discriminatory employers make lower profits (Hellerstein *et al.*, 2002; Kawaguchi, 2007) and are more likely to exit the market (Weber and Zulehner, 2014). Employers actually seem to pay for discrimination.

For discrimination to prevail, discriminatory employers must possess some market power on their product markets enabling them to indulge their costly preferences. Otherwise, discrimination would simply be competed away. And thus, the strength of product market competition should put limits on the viability of discrimination, with gender pay gaps being lower in more competitive environments. Following this line of reasoning, we investigate

1 Weichselbaumer and Winter-Ebmer (2005) provide a large meta-analysis of more than 260 international studies on the gender pay gap between the 1960s and the 1990s.

whether strong product market competition reduces gender wage discrimination in West Germany and whether this effect is more pronounced in the so-called codetermination-free sector, i.e. in plants with neither collective agreements nor a works council. Other than previous studies, we use linked employer–employee panel data that include a plant-level assessment of the strength of product market competition.

Almost exclusively, extant studies have used aggregate or indirect measures of competition such as the intensity of international trade (Black and Brainerd, 2004; Juhn *et al.*, 2014), the extent of market regulation (Black and Strahan, 2001), market structure (Winter-Ebmer, 1995; Heyman *et al.*, 2013), or combinations of these (Jirjahn and Stephan, 2006; Weichselbaumer and Winter-Ebmer, 2007; Zweimüller *et al.*, 2008; Heinze and Wolf, 2010). Such measures, however, suffer from several shortcomings: (i) Although these proxies may be informative on the average intensity of product market competition within a product market, they do not provide information on changes in competitive pressure at the level of the individual firm where decision-making takes place. Even worse, using these measures requires the researcher to implicitly define plants' relevant product and geographical markets, which turns out to be far from non-trivial. Notably, the inevitable problems in doing so in a convincing and unambiguous way drove the German Monopolies Commission to cease reporting classic concentration measures, like the Herfindahl index or the concentration ratio, altogether (Monopolies Commission, 2012, p. 12). (ii) Through the lens of the structure–conduct–performance paradigm, utilising these measures also claims that market structure uniquely determines market participants' behaviour thereby abstracting from different ways of competition on different product markets that may add further ambiguity to the proxy at hand. (iii) Also, a possible correlation between such a proxy variable of product market competition and individual wages may not only point at the effect of competitive pressure on wages but also at other things captured by the proxy variable (e.g. higher *ex-ante* productivity of exporting firms such as in Melitz (2003)-type models). To sidestep these problems related to aggregate or indirect proxies of product market competition, we will use a direct plant-level measure of competitive pressure based on a self-assessment by plants' managers. Therefore, we do not have to define plants' relevant market *ex ante*, and basing our measure on the beliefs of plants' managers about competition guarantees that it is relevant for managements' decisions-making.

To the best of our knowledge, Belfield and Heywood (2006) and Hirsch *et al.* (2012) are the only ones in this strand of the literature to base their evidence on direct information on the competition faced by individual firms. While Hirsch *et al.* (2012) find a negative correlation between firms' self-assessment on product market competition and the unexplained gender pay gap in West Germany, Belfield and Heywood (2006) document a negative link for the U.K. that is more pronounced in the non-unionised sector. Both studies, however, rely on cross-sectional data only. They thus cannot rule out that differences in pay gaps reflect unobserved heterogeneity among firms facing different levels of product market competition and/or self-selection of workers into firms with different competitive pressure, rather than a genuine competition effect.

Against this background, our study contributes to the literature in three ways: First, our panel data permit us to investigate the impact of plant-level product market competition on the unexplained gender pay gap controlling for match fixed effects, i.e. time-invariant unobserved heterogeneity for every plant–worker pair. We thus base our investigation on direct information on the competition faced by plants, with identification relying on the differential impact of within-plant variation in competitive pressure on within-plant wage growth of men and women. As a consequence, estimated effects are neither contaminated by unobserved time-invariant plant heterogeneity nor by self-selection of workers.

Second, apart from identification, we add to the literature by investigating heterogeneities in the competition effect on gender wage discrimination by plants' industrial relations regime. German industrial relations are characterised by a dual system of worker representation through (sectoral) trade unions and works councils that can be elected by the workforce in plants with at least five employees (for details, see Keller, 2004, or Addison, 2009). As plants' discretion to alter wages in response to changes in competitive pressure should be more limited if they are bound by a collective agreement or if they have a works council, we analyse whether the competition effect is stronger in the sector with none of these types of worker representation (which in Germany is usually referred to as the codetermination-free sector).

Third, we investigate whether the effect is larger in plants with a below-average share of females in their workforces. Since theory suggests that these plants have more pronounced discriminatory preferences, a stronger competition effect in these plants would further substantiate that fierce competition limits taste-based employer discrimination.

The remainder of this paper is organised as follows: Section 2 describes our data set and Section 3 our econometric approach. Section 4 presents and discusses our results, and Section 5 concludes.

2 Data

The data used in this paper consist of three waves of the cross-sectional model of the linked employer–employee data set of the Institute for Employment Research (LIAB) for the years 2008–2010 (for details, see Alda *et al.*, 2005, and Heining *et al.*, 2013). The data set links the IAB Establishment Panel, a representative survey of German plants (not companies), to the administrative data on all those individuals who work for these plants and contribute to the social insurance system.

The administrative data are based on the notification procedure for the German health, pension, and unemployment insurances. This requires all employers to report the necessary information on their workers if covered by the system, where misreporting is legally prohibited. Thus, among others, civil servants, self-employed, and individuals in marginal employment are not included. All in all, about 80 per cent of all people employed in Germany are covered by the social security system. *Inter alia*, the data include information for every worker on the daily gross wage, age, education, sex, nationality, tenure, occupation, and industry at the 30th of June of a year.

The employer side of our data comes from the IAB Establishment Panel (for details, see Kölling, 2000), a stratified random sample of all plants that employ at least one worker covered by the social security system at the 30th June of a year. Starting in 1993, the IAB Establishment Panel has surveyed plants from all industries in West Germany. Response rates of units that have been interviewed repeatedly exceed 80 per cent. Questions deal, among other things, with the number of workers, the composition of the workforce, the plant's commitment to collective agreements at sector or plant level, the existence of a works council, the plant's exporting activity, and its production technology.

From 2008 onwards, the data additionally include a plant-level self-assessment of product market competition on a four-point Likert scale that enables us to distinguish plants facing strong competition from other plants.[2] Using this information we set up a panel data set for West Germany and the years 2008–2010 to investigate the effect of product market competition on the gender pay gap in profit-oriented plants.

Whereas the wage information included in the LIAB is highly reliable, there are two shortcomings of the data crucial to our investigation: Firstly, the data set includes daily wages only and no detailed information on working hours. As a consequence, we have to exclude part-time workers. Secondly, wages are top-coded at the social security contribution ceiling which affects 16.2 per cent of our male and 6.0 per cent of our female observations. To deal

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[2] In our sample, 4.3 per cent of plants report "no pressure from competition at all", 11.1 per cent "minor pressure from competition", 38.5 per cent "medium pressure from competition", and 46.1 per cent "substantial pressure from competition", where we take the latter category as an indicator of strong competition in the plant's product market.

with this second issue, we apply the standard single imputation procedure proposed by Gartner (2005) and impute top-coded wages. In a first step, we estimate yearly Tobit models for each combination of sex and competition (e.g. females working for plants facing strong competition), where the regressand is the log daily gross wage and the regressors are those included in the further analysis. In a second step, for every observation with a top-coded wage a random value is drawn from a normal distribution left-truncated at the respective social security contribution ceiling with predicted log wage as mean and standard deviation as estimated from the Tobit models.[3]

All in all, we end up with a sample of 1,239,911 observations of 627,076 male workers and 305,876 observations of 166,759 female workers employed by 6,114 plants. As can be seen from Table 1, 66 per cent of male and 61 per cent of female observations belong to plants facing strong product market competition. Further, 6 per cent of male and 10 per cent of female observations are in the codetermination-free sector, i.e. work in plants that are neither bound by collective agreements nor have a works council. Turning to wages, women earn about 21 per cent lower wages than men on average. This number hardly changes when considering the subgroups of workers working for plants facing strong or weak competition, though workers' wages are generally higher in plants with strong competitive pressure. (For more descriptive statistics, see the Appendix Table.)

– TABLE 1 ABOUT HERE –

As the transition matrix in Table 2 makes clear, plants' self-assessment on product market competition is extensively varying over time. During our period of observation, 1,715 transitions between strong and weak competition take place compared to 5,077 instances where competition stays constant. As a consequence, 23 per cent or 171,369 out of 751,952

3 As a check of robustness, we also redid our analysis excluding observations with top-coded wages from the sample, which did not change our insights.

workers are employed in plants with changing product market competition thereby enabling us to rest identification on within-plant variation in competition.

– TABLE 2 ABOUT HERE –

3 Econometric Approach

To test the hypothesis that product market competition lowers the gender pay gap, we will run augmented Mincerian wage regressions. Our baseline specification is a fully interacted model

$$\ln w_{ijt} = \pi_1 fem_i + \pi_2 comp_{jt} + \pi_3 comp_{jt} \times fem_i + \mathbf{x}'_{it}(\boldsymbol{\alpha} + \boldsymbol{\beta} \times fem_i) \qquad (1)$$
$$+ \mathbf{z}'_{jt}(\boldsymbol{\gamma} + \boldsymbol{\delta} \times fem_i) + \varepsilon_{ijt},$$

where $\ln w_{ijt}$ is the log gross daily wage of worker i working for plant j in period t, fem_i is a female dummy, $comp_{jt}$ is a dummy indicating strong product market competition, $comp_{jt} \times fem_i$ is the interaction of these two, and π_1, π_2, and π_3 are the corresponding coefficients. Furthermore, $\mathbf{x}_{it}$ denotes a vector of worker characteristics, $\mathbf{z}_{jt}$ a vector of plant characteristics, ε_{ijt} the idiosyncratic error component, and $\boldsymbol{\alpha}$, $\boldsymbol{\beta}$, $\boldsymbol{\gamma}$, and $\boldsymbol{\delta}$ the corresponding coefficient vectors.

Worker controls comprise potential experience and tenure (both linearly and squared), dummy variables for joining the plant before 1975 (i.e. censored job tenure), five levels of education, non-German nationality, year of observation, and three-digit occupation. Plant controls include log plant size and its square, the shares of female and low-skilled workers in the plant's workforce, dummies for works council existence, a collective agreement at either firm level or sector level, exporting activity, new production technology, plant location in a rural area, and one-digit industry.

To ease interpretation, all regressors are centred around their sample averages, so that π_1 can be interpreted as the average unexplained gender pay gap in the full sample. The coefficients of main interest are π_2 and π_3, where π_2 gives the effect of strong product market competition on males' wages and π_3 the difference in the competition effect across the sexes. We expect strong competition to depress the overall rents accruing and thus workers' wages in general. Moreover, strong competition should also confine employers' ability to discriminate against women by sharing rents disproportionately with male workers (cf. Black and Strahan, 2001). Hence, we expect π_2 to have a negative sign and π_3 to have a positive sign, the latter indicating that strong competition reduces the gender pay gap by inducing a smaller adverse effect on females' compared to males' wages.

In this baseline specification, identification rests on both inter-plant and within-plant variation in competition. It is therefore unclear whether the results are driven by unobserved plant heterogeneity correlated with plants' competitive pressure or by a genuine competition effect. To come closer to the true competition effect, we next add plant–sex fixed effects to the model, i.e. we control for permanent differences in plants' sex-specific wage policies. As discussed in Section 2, this is viable in our data as we have sufficiently many plants with varying product market competition over time. Our second specification thus is

$$\ln w_{ijt} = \pi_2 comp_{jt} + \pi_3 comp_{jt} \times fem_i + \mathbf{x}'_{it}(\boldsymbol{\beta} + \boldsymbol{\gamma} \times fem_i) \qquad (2)$$
$$+ \mathbf{z}'_{jt}(\boldsymbol{\alpha} + \boldsymbol{\delta} \times fem_i) + v_j + \zeta_j \times fem_i + \varepsilon_{ijt},$$

where the plant fixed effect for men and women is v_j and $v_j + \zeta_j$, respectively.[4] In this second specification, identification of π_2 and π_3 relies on within-plant variation in competition and the accompanying changes in male and female workers' wages. Hence, π_2

[4] Note that the coefficient of the female dummy π_1 is no longer identified when adding plant–sex or match fixed effects.

tells us how males' wages and π_3 how the unexplained gender pay gap responds to intensified competition.

That said, changes in workers' wages due to varying competition may stem from two different sources: Either varying competition triggers wage changes for on-going jobs, i.e. for given worker–plant pairs, or wages change due to altering worker composition. And workers with different unobserved characteristics, like motivation, career outlook, or mobility, may self-select themselves into plants with different competitive pressure. As women and men have been found to differ considerably in both career aspirations and job mobility (e.g. Chevalier, 2007, and Hirsch and Schnabel, 2012), self-selection of workers may contaminate within-plant comparisons of unexplained gender pay gaps. In order to address self-selection of workers, we next include match fixed effects to our model, i.e. we control for the permanent wage component of every worker–plant pair. Hence, our third specification is given by

$$\ln w_{ijt} = \pi_2 comp_{jt} + \pi_3 comp_{jt} \times fem_i + \mathbf{x}'_{it}(\boldsymbol{\beta} + \boldsymbol{\gamma} \times fem_i) \quad (3)$$
$$+ \mathbf{z}'_{jt}(\boldsymbol{\alpha} + \boldsymbol{\delta} \times fem_i) + \phi_{ij} + \varepsilon_{ijt}$$

with match fixed effect ϕ_{ij}. In this final specification, identification of π_2 and π_3 rests solely on changes in workers' within-plant wage growth occurring simultaneously to within-plant variation in competition, i.e. wage changes within a given worker–plant pair. Estimated competition effects are thus free from biases stemming from unobserved heterogeneity in plants' permanent sex-specific wage policies and self-selection of workers with different unobserved time-invariant characteristics. A fall in workers' within-plant real wage growth may stem from various channels, such as decreased bonus payments, below-inflation nominal wage increases, or a reduction in the wage cushion between contract wages and effective wages.

We should make clear, though, that both specifications (2) and (3) just identify short-run effects of product market competition on workers' wages, i.e. changes in wages occurring simultaneously to within-plant variation in competition. However, long-run effects, which we cannot identify given the short time horizon of our data, may be larger as it may take some time for employers to alter wages. Furthermore, plants' discretion to adjust wages in the short run is likely to differ depending on their industrial relations regime. Arguably, plants bound by legally binding collective agreements may find it harder to cut wages in response to intensified competitive pressure. In a similar vein, works councils are likely to protect workers' rents and lower plants' discretion to reduce wages in such an event.[5] We thus expect to find marked competition effects only in plants belonging to the codetermination-free sector.

4 Results

Running the three wage regressions (1)–(3) on our full sample yields the results summarised in Table 3. In the OLS specification, we find a highly significant average unexplained gender pay gap of 14.6 log points, which is similar in magnitude to previous studies for West Germany, such as Gartner and Hinz (2009) and Hirsch (2013). As can be seen from the estimated coefficient of the competition dummy, male workers' wages are 1.1 log points lower in plants facing strong product market competition which is statistically insignificant at conventional levels. The interaction effect of the female and the competition dummy indicates that the competition effect is almost zero and statistically insignificant.

– TABLE 3 ABOUT HERE –

The picture hardly changes when resting identification on within-plant variation in competition in specifications (2) and (3). Intensified competition lowers male workers' wages

5 Strictly speaking, German labour law precludes works councils from directly negotiating wages (which is the task assigned to trade unions). Yet, the extensive veto powers enjoyed by works councils in non-wage areas give them sufficient bargaining leverage to pressure management not to cut wages (cf. Addison *et al.*, 2001).

by 0.8 (0.9) log points in the specification with plant–sex (match) fixed effects, where the coefficient is statistically significant at the 5 (10) per cent level. Yet, the interaction effect of the female and the competition dummy is still very small and statistically insignificant throughout. So in the full sample there is no indication of a differential short-run effect of intensified product market competition on female and male workers' wages and thus no evidence of a (levelling) competition effect on gender wage discrimination.

However, as discussed in Section 3, short-run effects are expected to be only visible in plants that possess enough discretion to adjust wages in the short run. We therefore think that effects are more likely to be visible in plants not subject to worker codetermination. To check this, we split our sample in two subsamples: plants bound by a collective agreement and/or having a works council and codetermination-free plants. The results of running wage regressions on both subsamples are summarised in Table 4.

– TABLE 4 ABOUT HERE –

In line with earlier contributions, like Jirjahn and Stephan (2006) or Heinze and Wolf (2010), the unexplained gender pay gap is lower if some sort of worker codetermination is present. In the OLS specification (1), the gap amounts to 22.3 log points in codetermination-free plants but just 14.7 log points in plants with worker codetermination. As expected, in codetermined plants workers' wages do not respond much to intensified competition. In the specifications with plant–sex or match fixed effects, an increase in competition causes male workers' wages to fall by 0.7–0.8 log points, where the effect is statistically insignificant in the specification including match fixed effects. Furthermore, as the interaction effect is almost zero there is clearly no differential effect across the sexes.

Results are different for the codetermination-free sector in which workers' wages are responding to intensified competition. This is in line with an earlier finding by Belfield and

Heywood (2006) for the U.K. that the cross-sectional link between competition and the gap is driven by the non-unionised sector. Depending on specification, males' wages decrease by 1.5–3.2 log points if competition gets fierce, where all effects are statistically significant at least at the 5 per cent level. As the interaction effect indicates that women's wages are considerably less depressed than men's, the unexplained gender pay gap is significantly reduced by 1.2–2.1 log points. In our preferred specification including match fixed effects and thus addressing unobserved plant heterogeneity and worker self-selection, intensified product market competition reduces males' wages by 1.9 log points while females' wages are almost unaffected as the interaction effect also accounts to 1.8 log points.[6] This is in line with our expectation that intensified competitive pressure reduces the rents accruing and thus restricts employers' ability to share rents disproportionately with male workers. Consequently, the unexplained gender pay gap falls by 1.8 log points if competition gets fierce. As the average gap in codetermination-free plants accounts to 22.3 log points, this means that it drops by about 8 per cent. Since this fall in the gap represents a short-run effect and the long-run effect is arguably larger, we regard the competition effect on the gender pay gap as non-trivial from an economic point of view.

To further scrutinise our results, we next split our sample by the share of females in plants' workforces. In Becker's (1971) model with taste-based employer discrimination, plants employing fewer women are not only more discriminatory employers but also less profitable. Therefore, we may expect the competition effect on the gender pay gap to be more pronounced in plants with a below-average share of female workers, which should be hit disproportionately by intensified product market competition.[7] To check this, we run wage regressions separately

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[6] Note that male workers' wages drop somewhat less in the specification with plant–sex fixed effects suggesting that specification (2) misses part of the competition effect due to workers self-selecting into plants where rents accruing are large.

[7] To be precise, this notion is not literally true in Becker's (1971) original model where the gender pay gap is the same for all women, no matter whether they work for discriminatory or non-discriminatory employers. However, this latter conclusion of the model hinges on the assumption that workers can instantaneously and

for workers employed by plants with below-average and plants with above-average shares of female workers (in the respective two-digit industry). Table 5 presents the estimated competition effects from our preferred specification with match fixed effects.

– TABLE 5 ABOUT HERE –

When not distinguishing plants depending on worker codetermination, intensified competition lowers the gender pay gap by 0.5 log points in plants with a below-average female share, which is not statistically significant. This levelling effect of product market competition is somewhat smaller (0.3 log points) in plants with some worker codetermination and much larger (2.0 log points) and statistically significant at the 5 per cent level in codetermination-free plants. Remarkably, competition has no effect on the gender pay gap in plants with an above-average female share. Since, according to theory, plants with a below-average female share are more discriminatory employers, these findings are suggestive that intensified product market competition indeed reduces gender discrimination stemming from employer prejudices against women.

5 Conclusions

Using linked employer–employee panel data for West Germany and the years 2008–2010 that include a plant-level self-assessment on product market competition we have investigated the

costlessly switch employers. Once one builds in some forces restricting worker mobility, it does not hold anymore. For instance, Bowlus and Eckstein (2002) incorporate discriminatory employer preferences into Mortensen's (1990) equilibrium search model with on-the-job search. They show that employers with more pronounced discriminatory preferences offer lower wages to women than employers with less pronounced tastes for discrimination and also end up with lower profits. Since intensified competition puts additional pressure on firm profitability, it restricts discriminatory employers' ability to pay for discrimination, and it does more so for more discriminatory employers who already make lower profits than their competitors. Hence, we expect the unexplained gender pay gap to fall to a larger extent in plants with a lower share of females in their workforces.

effect of competition on the gender pay gap. In our preferred specification, we control for match fixed effects thereby resting identification on the differential impact of within-plant variation in competitive pressure on within-plant wage growth of men and women. We thus address both unobserved time-invariant plant heterogeneity and worker self-selection into plants facing different levels of competition.

In plants without any worker codetermination, we find that intensified competition significantly lowers the unexplained gender pay gap by 1.8 percentage points. On the other hand, there is no levelling effect of competition in plants bound by collective agreements and/or having a works council, which is plausible as these are unlikely to have enough discretion to adjust wages in the short run. These results are in line with Becker's (1971) model of taste-based employer discrimination where competition limits employers' ability to discriminate against women.

We also document that there is a more pronounced competition effect on the gap in plants with a below-average share of females in their workforces and that such an effect is generally absent for plants with an above-average female share. Since, according to theory, employers employing fewer women are more discriminatory, these findings are suggestive that competition indeed restricts gender wage discrimination rooting in employer prejudices against women.

Although we were able to improve on earlier contributions particularly in terms of identification, the brief time horizon of our panel data did only permit us to identify the short-run effect of product market competition on gender wage discrimination. While this short-run effect turned out to be non-trivial in magnitude, the long-run effect is likely to be larger and we therefore regard our estimates as a lower bound of the competition effect. To investigate the long-run effect of product market competition on the gender pay gap seems to be a promising avenue for future research.

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Table 1: Wages by sex and product market competition

	Women		Men	
	Mean	Std. dev.	Mean	Std. dev.
Full sample				
Gross daily wages (in €)	104.36	45.90	132.41	50.47
Log gross daily wages	4.55	0.44	4.82	0.38
Strong product market competition (dummy)	0.61	0.49	0.66	0.47
Codetermination-free plant (dummy)	0.10	0.30	0.06	0.24
Observations	305,876		1,239,911	
Workers	166,759		627,076	
Plants	6,114			
Plants facing weak product market competition				
Gross daily wages (in €)	99.00	43.86	126.10	48.77
Log gross daily wages	4.50	0.44	4.77	0.38
Codetermination-free plant (dummy)	0.14	0.35	0.09	0.29
Observations	120,176		424,971	
Plants facing strong product market competition				
Gross daily wages (in €)	107.83	46.84	135.70	51.02
Log gross daily wages	4.59	0.44	4.84	0.37
Codetermination-free plant (dummy)	0.07	0.25	0.04	0.20
Observations	185,700		814,940	

Notes: LIAB cross-sectional model, West Germany, 2008–2010. Wages are deflated by the consumer price index. Strong product market competition refers to the highest category on a four-point Likert scale of a plant-level self-assessment of competition.

Table 2: Transitions between strong and weak product market competition

Initial product market competition	Product market competition in the next period			
	Plants		Workers	
	Weak $(t+1)$	Strong $(t+1)$	Weak $(t+1)$	Strong $(t+1)$
Weak (t)	2,751	842	180,034	88,965
Strong (t)	873	2,326	82,404	400,549

Notes: LIAB cross-sectional model, West Germany, 2008–2010. Strong product market competition refers to the highest category on a four-point Likert scale of a plant-level self-assessment of competition.

Table 3: Wage regressions (full sample)

	(1)	(2)	(3)
	OLS	Plant–sex fixed effects	Match fixed effects
Strong product market competition	-0.0112 (0.0068)	-0.0082** (0.0041)	-0.0094* (0.0049)
Female × strong product market competition	0.0015 (0.0062)	0.0019 (0.0033)	0.0016 (0.0039)
Female	-0.1460*** (0.0032)		
Observations		1,545,787	

Notes: LIAB cross-sectional model, West Germany, 2008–2010. The regressand is the log gross daily wage. Standard errors in parentheses are clustered at the plant level. ***/**/* denotes statistical significance at the 1/5/10 per cent level. In Model 1, additional regressors are potential experience and tenure (linearly and squared), dummy variables for joining a plant before 1975, five levels of education, and non-German nationality, the shares of female and low-skilled workers in the plant's workforce, log plant size and its square, and dummies for works council existence, a collective agreement at either firm level or sector level, exporting activity, new production technology, plant location in a rural area, one-digit industry, three-digit occupation, and year of observation. Model 2 additionally includes plant–sex fixed effects whereas Model 3 includes match fixed effects. All regressors are centred around their sample averages and also interacted with the female dummy.

Table 4: Wage regressions by worker codetermination

	(1) OLS	(2) Plant–sex fixed effects	(3) Match fixed effects
Plants with some worker codetermination			
Strong product market competition	-0.0092 (0.0072)	-0.0073* (0.0043)	-0.0077 (0.0049)
Female × strong product market competition	-0.0002 (0.0066)	0.0010 (0.0034)	-0.0006 (0.0037)
Female	-0.1471*** (0.0035)		
Observations		1,442,439	
Codetermination-free plants			
Strong product market competition	-0.0320*** (0.0111)	-0.0152** (0.0075)	-0.0187** (0.0087)
Female × strong product market competition	0.0209* (0.0127)	0.0116* (0.0067)	0.0176** (0.0080)
Female	-0.2227*** (0.0250)		
Observations		103,348	

Notes: LIAB cross-sectional model, West Germany, 2008–2010. The regressand is the log gross daily wage. Standard errors in parentheses are clustered at the plant level. ***/**/* denotes statistical significance at the 1/5/10 per cent level. Regressors are those listed in Table 3.

Table 5: Wage regressions with match fixed effects by worker codetermination and the share of females in plants' workforces

	Effect of intensified product market competition on the unexplained gender pay gap		
	All plants	Plants with worker codetermination	Codetermination-free plants
All plants	0.0016 (0.0039)	-0.0006 (0.0037)	0.0176** (0.0080)
Plants with below-average share of females	0.0045 (0.0042)	0.0028 (0.0041)	0.0196** (0.0077)
Plants with above-average share of females	0.0008 (0.0033)	0.0001 (0.0036)	-0.0026 (0.0061)

Notes: LIAB cross-sectional model, West Germany, 2008–2010. The regressand is the log gross daily wage. The coefficient shown is the interaction effect of the competition and the female dummy. Standard errors in parentheses are clustered at the plant level. ***/**/* denotes statistical significance at the 1/5/10 per cent level. Regressors are those listed in Table 3.

Appendix

Appendix Table: Descriptive statistics

	Women		Men	
	Mean	Std. dev.	Mean	Std. dev.
Potential experience (years)	22.0	11.5	23.8	10.2
Tenure (years)	10.7	8.6	13.2	9.3
Tenure censored (dummy)	0.023	0.151	0.031	0.173
Apprenticeship, no Abitur (dummy)	0.600	0.490	0.674	0.469
No apprenticeship, Abitur (dummy)	0.021	0.142	0.010	0.102
Apprenticeship, Abitur (dummy)	0.100	0.300	0.044	0.206
Technical college degree (dummy)	0.040	0.195	0.070	0.255
University degree (dummy)	0.071	0.257	0.086	0.280
Non-German nationality (dummy)	0.069	0.254	0.074	0.261
Share of female workers	0.399	0.239	0.211	0.159
Share of lowly qualified workers	0.231	0.247	0.192	0.223
Works council (dummy)	0.813	0.390	0.885	0.319
Collective bargaining at firm level (dummy)	0.148	0.355	0.165	0.371
Collective bargaining at sector level (dummy)	0.645	0.478	0.704	0.457
Exporting activity (dummy)	0.607	0.488	0.767	0.423
New production technology (dummy)	0.837	0.370	0.840	0.366
Plant in rural area (dummy)	0.177	0.382	0.173	0.378
Plant size (number of workers)	5,420	11,967	8,610	15,100
Observations	305,876		1,239,911	

Notes: Tenure is left-censored if the worker's jobs with the plant started before 1975. The data set used is the LIAB cross-sectional model, waves 2008–2010.