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Where do women earn more than men? Explaining regional differences in the gender pay gap

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Abstract

This paper provides new evidence on the magnitude and determinants of regional differences in the gender pay gap. On the basis of a comprehensive data set of all full-time employees in Germany, we explain the profound variation of the gender pay gap at a small-scale level with theory-based individual and job-related characteristics. Using the Oaxaca–Blinder decomposition, we find pronounced spatial differences in the impact of the considered determinants. Whereas gender differences in job-related characteristics are important drivers in regions with a high gender pay gap, individual characteristics come into effect in regions with a low and negative gap. The results underscore the role played by the establishment composition in a region and the kind of jobs provided for gendered earnings.

KEYWORDS

decomposition, gender pay gap, Germany, regional labor markets, wages

1 | INTRODUCTION

Regional inequalities in wages constitute a widespread phenomenon that is of great importance to policymakers and the general public alike. Though their general magnitude and determinants have been subject to intense research (e.g., Combes et al., 2008; López-Bazo & Motellón, 2012; Pereira & Galego, 2011), much less is known about gender

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differences in regional wages. Lower wages of women as illustrated by the gender pay gap (GPG) constitute a highly political and societal issue that persists not only between countries (OECD, 2017) but also between smaller regional units. Germany, for example, being characterized by striking regional disparities on the labor market (OECD, 2005), features a nationwide GPG of 20.1% that hides a range of -4.3% to 40.3% on the level of the NUTS 3 regions. These profound disparities in the GPG clearly call for an explanation, as they entail unequal chances for men and women in the labor market and social context both across and within regions. However, only a few studies dealing with regional wage disparities take gender issues into account (e.g., Ammermüller et al., 2010; Duranton & Monastiriotis, 2002; Galego & Pereira, 2014), whereas studies that explicitly deal with gender differences in regional wages mainly focus on the contrast between rural and urban regions (Bacolod, 2017; Glaeser & Maré, 2001; Hirsch et al., 2013; Nisic, 2017). To the best of our knowledge, so far only Murillo Huertas et al. (2017) explicitly investigate regional differences in the GPG in a comprehensive way. They document significant spatial heterogeneity at the NUTS 2 level in Spain, which they trace back to spatial variation in economic, institutional, and demographic factors.

As to the GPG itself, a vast body of literature has uncovered a variety of individual and establishment-related determinants ranging from gender differences in human capital (Becker, 1964) and labor market experience (Combet & Oetsch, 2019; Manning & Swaffield, 2008) as well as in occupational choice (England, 1992; Marini, 1989; Polachek, 1981) to the impact of gender roles and noncognitive skills (Blau & Kahn, 2017) and the sorting into firms (Card et al., 2016; Barth et al., 2017). As these factors are implicitly assumed to be relevant for explaining the GPG at the national level, a fundamental question that arises in regional respect is if and to what degree they also hold at the subnational level. In close relation is the question to what extent gender-specific wage differences depend on the structure of human capital and firm-specific factors varying between regions. There are several reasons why this should be the case. Foremost, individual skills and labor market participation that go along with different social norms across regions (Yeandle, 2009) are not evenly distributed across locations (Combes & Gobillon, 2015). Furthermore, regions differ substantially in their sectoral and establishment composition, thereby providing different regional employment opportunity structures for men and women (Hanson & Pratt, 1995; Nisic, 2017; Perales & Vidal, 2015; Petrongolo & Ronchi, 2020). One explanation for these spatial disparities is agglomeration effects that increase productivity and hence wages by improving the quantity and quality of matches between workers and firms in dense labor markets (Glaeser & Maré, 2001). They affect men and women in different ways. For example, due to more and better job opportunities in dense agglomerations, women may experience a lower wage depreciation resulting from time out of employment than women in rural areas (Phimister, 2005). Related, agglomerative forces should lead to higher productivity of specific cognitive and social skills that women display relatively more often than men (Bacolod, 2017). A further factor pertains to the lower spatial mobility of women that restricts their job search to a smaller area and thus hinders them from getting better jobs and higher wages in other regions (Crane, 2007; Petrongolo & Ronchi, 2020). Consequently, the determinants that influence the GPG in general terms should also be distributed unevenly at the regional level.

This paper provides new answers to the questions posed above by explaining regional differences in the GPG within Germany, extending the findings of Murillo Huertas et al. (2017) for Spain. To this, we apply the decomposition method of Oaxaca (1973) and Blinder (1973) for all 401 German NUTS 3 regions, which enable a more disaggregated analysis than the NUTS 2 regions used by Murillo Huertas et al. (2017). In addition, our analysis rests on microlevel data for the year 2017 with detailed information on the whole population of employees covered by the German social security system as well as on all establishments employing these persons.

The paper contributes to the existing literature in several ways. First, we identify at the national level the role of decidedly regional factors that we consider in addition to the commonly used individual and establishment determinants of the GPG. The second and main contribution consists of examining for each region the impact of the factors identified in the literature as driving the GPG and how this impact differs across the regions. For this purpose, we compare the regional impacts of the factors to assess whether they are valid across all regions or only for specific groups of regions.

The paper is structured as follows. Section 2 introduces the data, and Section 3 presents the decomposition method used in our analysis. Section 4 derives the explanatory variables of the GPG against the background of

theoretical considerations and empirical evidence. In Section 5, we present the results. While Section 6 contains robustness checks, Section 7 concludes.

2 | DATA

Our main data set is the Employee History (BeH) of the Institute of Employment Research (IAB). It covers all employment notifications in Germany, providing information on all employees subject to social security and the establishments they work in. For each employee, the BeH contains a detailed set of sociodemographic and employment characteristics. For each establishment, information on its location and branch of industry is included. As they are not covered by social security, civil servants, persons in military service, and self-employed are excluded. Due to legal sanctions for misreporting, the data is very reliable.

The BeH brings along the decisive advantage of providing the population of employees and establishments in a small-scale regional perspective, going beyond survey data used by the few related studies of Murillo Huertas et al. (2017), Bacolod (2017), or Nisic (2017). However, there are also some constraints that arise from the specific collection purpose. First, wages are right-censored, because they are only reported up to the social security contribution limit. To avoid biased estimates, we follow Gartner (2005) and impute censored wages with estimated wages.¹

Second, the German social security data does not contain information on the exact number of hours worked. This implies that we have to explicitly exclude one important source for gender differences in earnings that rests on female part-time employment (Boll et al., 2016; Manning & Petrongolo, 2008).² As an advantage, however, the restriction on full-time employees allows us to investigate the GPG for a more homogenous group. In addition, we control for the selection into employment by capturing biases induced by non-employment (Olivetti & Petrongolo, 2008). To this, we estimate for each employee the probability of being full-time employed by means of a probit model and include the resulting inverse mills ratio as an additional determinant of the GPG in the decomposition.³

Third, due to the specific data collection purpose, we cannot directly control for marital status and the number of children that restrict women's labor supply (Blau & Kahn, 2017). To indirectly account for related employment interruptions, we additionally consider individual labor market biographies provided by the Integrated Employment Biographies (IEB) of the IAB. This data set contains information on employment spells, benefit receipts, participation in measures of active labor market policy, and job-search status for every person on a daily basis.

Additional information on the establishments comes from the Establishment History Panel (BHP) of the IAB that contains detailed information about all establishments in Germany with at least one employee liable to social security or with at least one marginal part-time employee. For the construction of further regional variables, we use data from the Federal Employment Agency on the unemployment rates, the German Statistical Office on population and fertility, and the German Microcensus on persons with Catholic denomination. The regional dimension of our analysis is delineated along the 401 German NUTS 3 regions covering *kreisfreie Städte* and *Landkreise*.

The BeH for 2017 encompasses about 35.4 million employees that we confine to full-time employees between 15 and 64 years of age. We further disregard apprentices and persons with missing information on wages. To properly calculate variables at the establishment level, for example, wage dispersion, we exclude establishments with one employee. Our final data set encompasses 17,933,369 observations, of which are roughly 12.3 million men and 5.7 million women.

¹Nine percent of the employees in our data set have wages above these thresholds. For the imputation, we estimate the wages with a Tobit regression, using basically the same explanatory variables as in the wage regressions (Gartner, 2005).

²We take up this issue in the robustness checks and conduct decompositions for full- and part-time workers using approximated information on working hours.

³The probit model contains a set of variables which significantly explain the likelihood to be in employment, but do not explain the wages (e.g., care facilities for children younger than 3 years on the NUTS 3 level).



3 | METHOD

For explaining regional differences in the unadjusted GPG, we follow the seminal work of Oaxaca (1973) and Blinder (1973) that has been widely used in subsequent wage gap studies (e.g., Fortin et al., 2011) and in assessing regional wage disparities (e.g., Murillo Huertas et al., 2017; Pereira & Galego, 2011). The classical Oaxaca–Blinder (OB) decomposition focuses on the gap in mean earnings between male and female workers. Formally, it consists of two estimation steps. First, estimations of the determinants of wages that are based on the Mincerian human capital earnings function (Mincer, 1974) are carried out separately for male (m) and female (f) workers. In a log-linear model, log wages (W) are regressed on a set of explanatory factors that comprise individual, establishment, and regional characteristics (X). They are henceforth referred to as endowments and are viewed as observable indicators of productivity differences partly explaining the pay gap. Formally, the regression equations look as follows, with β^j representing the estimated coefficient of the characteristic indexed by j , the region under consideration characterized by r , and ε denoting a residual term:⁴

$$\ln W_{m,r} = \beta_{m,r}^0 + \sum_j \beta_{m,r}^j X_{m,r}^j + \varepsilon_{m,r}, \quad (1)$$

$$\ln W_{f,r} = \beta_{f,r}^0 + \sum_j \beta_{f,r}^j X_{f,r}^j + \varepsilon_{f,r}. \quad (2)$$

Second, the resulting coefficient estimates, in combination with the gendered endowments, are used to decompose the gender difference in the average wage levels (\bar{W}). This is achieved by replacing gender-specific log mean wages with the right-hand side regression results of Equations (1) and (2). Following Blinder (1973), rearranging terms yields the following expression:

$$\ln \bar{W}_{m,r} - \ln \bar{W}_{f,r} = \underbrace{\sum_j (\bar{X}_{m,r}^j - \bar{X}_{f,r}^j) \beta_{m,r}^j}_{\text{explained part}} + \underbrace{\sum_j (\beta_{m,r}^j - \beta_{f,r}^j) \bar{X}_{f,r}^j + (\beta_{m,r}^0 - \beta_{f,r}^0)}_{\text{unexplained part}}. \quad (3)$$

The overall or unadjusted GPG is thus split into two components. The first component represents the part of the GPG attributable to gender differences in observed endowments, whereas (\bar{X}) denotes the average characteristics by gender and region. It is, therefore, termed the explained part. The second component is called the unexplained part or adjusted GPG and shows which part of the wage gap is due to the fact that the same endowment generates different market returns for male and female workers. This component also includes the constant. It captures the influence of all unobserved wage determinants on the GPG that we cannot control for in our model due to data restrictions. Such determinants may be personal ability, negotiating skills, or the institutional setting.

4 | REGIONAL GENDER PAY GAPS AND THEIR DETERMINANTS

Our central variable is the GPG per region. It is based on the daily nominal wages of all female and male full-time employees between 15 and 64 years of age with their place of work in a specific NUTS 3 region in Germany as of June 30, 2017. Measuring wages at the place of work is preferable to the place of residence (Glaeser & Maré, 2001), as this is where employers are located and wages are determined. We calculate the regional GPG as the difference between the log average wages of men and women (Blau & Kahn, 2017).

⁴In containing variables for individuals, establishments, and regions, Equations (1) and (2) combine information on different levels of observation. This multilevel structure can result in inefficient estimates of the coefficients and in biased estimates of the standard errors especially of the variables for the higher level (Moulton, 1990). To deal with this problem, clustering-robust linear regression techniques are used to estimate standard errors that recognize this clustering of the data.

Among the vast range of factors that are responsible for women's lower wages, we focus on the theory-based individual, establishment, and regional determinants that have been found to be relevant in the explanation of both international and interregional differences in the GPG (Blau & Kahn, 2017; Murillo Huertas et al., 2017). Detailed definitions, as well as descriptive statistics by gender, are provided in Tables A1 and A2 in the appendix.

Besides general sociodemographic features like age, qualification,⁵ or nationality, individual determinants cover the lower labor market experience of women that leads to a devaluation of their human capital and, thus, to lower wages (Becker, 1964; Blau & Kahn, 2017). We measure the returns of human capital along two different dimensions, namely firm-specific labor market experience or tenure and career interruptions.⁶ This way, we indirectly consider parental leave and childcare periods, which strongly depend on the local provision of childcare facilities. Related, the kind of employment contract matters, specifically holding a temporary contract (Booth et al., 2002). Because temporary positions are more frequently held by women than by men, they contribute not only to lower wages in general but press down the wages of women in particular (Boll et al., 2016).

Further individual determinants concern self-selecting processes in the choice of occupation that go along with labor market segregation. The occupational decision is generally taken at a young age, with interests, personal preferences, and social norms probably being more influential than the consideration of future wages. This behavior might unconsciously be channeled into gender-specific (entry) jobs (Polachek, 1981), resulting in the observation that women tend to work in low-paid occupations and men in high-paid occupations (England, 1992). For example, women often acquire professions in the traditionally female-dominated fields of caring and nursing, which are generally characterized by lower wages than typical "male" jobs (Marini, 1989). Besides controlling for occupation⁷ and, thus, horizontal segregation, we further take into account vertical segregation, which is related to the existence of a "glass ceiling" for women in leading positions (Arulampalam et al., 2007; Fortin et al., 2017). We approximate the under-representation of women in top jobs by having a supervisory position.

As regional labor markets are closely connected via dense interregional commuting patterns between the place of work and the place of residence, we control for each employee's interregional mobility.⁸ Because women have lower spatial mobility than men that restricts their job search to a smaller area, they might not benefit from better jobs and higher wages in other regions (Crane, 2007; Petrongolo & Ronchi, 2020). This especially concerns women in rural areas, where their wages are additionally under pressure by less competitive labor markets and consequently higher possibilities of employers to discriminate against them (Hirsch et al., 2013). Again, family responsibilities are a major driving force for women to find a job near their place of living (Nisic, 2017). To consider the divergent mobility patterns between genders, we include a dummy for commuters who live outside the region of work under consideration. Moreover, we control for the selection into the region related to the current job with a dummy, that is, whether a person changed the place of work specifically for the job obtained in 2017. Last, we specify how long an individual has been working in the region under consideration by calculating his or her regional labor market experience.

Establishment characteristics cover gender differences in the sorting into firms that provide further reasons for women's lower wages. First of all, women are more likely to be employed in low-wage firms than men, which can be explained by a combination of sorting and bargaining effects (Barth et al., 2017; Card et al., 2016). In addition and related to the underrepresentation of women in top jobs, pay-attractive jobs might be offered on gender-specific internal markets only that typically exist in large firms (Oi & Idson, 1999). To account for firm-specific labor markets, we include establishment size as well as the wage level and the wage dispersion within the establishment. The two latter

⁵The qualification variable in the BeH is based on reports by employers, which comes along with missing information for some spells in the data set as well as with inconsistencies for a person over time. To improve the information in this variable, we follow the procedure of Fitzenberger et al. (2006) and impute the likely qualification from past or future values. Initially, qualification information was missing for 32% of the spells. After using information from prior and subsequent spells, we end up with 9% missing, which we exclude from the analysis. Conducting the decomposition without imputed qualification variable does not change the results.

⁶We do not include general labor market experience because of its high correlation with age and career interruptions.

⁷Due to the high degree of collinearity between occupations and sectors, we only include the occupation in our models.

⁸We check for any biases due to individual mobility in the robustness checks.

variables also serve as proxies for a high-wage or a low-wage establishment and the provision of pay-attractive jobs and career possibilities. A further dimension of gender segregation across firms manifests itself in the vast differences in the shares of men and women in the firms' workforce (Card et al., 2016). Therefore, we consider the share of women on all employees within the establishment. Last, we include information on the workforce's qualification structure to account for human capital intensity at the establishment level.

Besides individual characteristics of the employees as well as special features of their workplaces, we consider the impact of gender differences in idiosyncratic regional variables on the GPG at the national level. First of all, global agglomeration effects are captured by labor market density, which additionally serves as a proxy for labor market thickness. Regional disparities in the GPG might further result from differences in the local demand for occupations and tasks (Combes & Gobillon, 2015). As women usually predominate in public and hospitality services and men in manufacturing and construction industries (Olivetti & Petrongolo, 2016), the regional sectoral structure should provide divergent employment opportunities for both genders (Hanson & Pratt, 1995; Perales & Vidal, 2015). They are controlled by the share of employees in the service sector, which benefits women. In addition, the female employment rate per region provides information on the respective female labor supply (Olivetti & Petrongolo, 2008). The unemployment rate characterizes the situation on the local labor market and any potential pressure on local wages (Ammermüller et al., 2010). As a further demographic component that simultaneously affects women's lifetime labor force participation (Polachek & Xiang, 2014) we include the fertility rate per region. Religious attachment captures traditional local behavior and social norms. Any specific characteristics in East Germany are taken into account by a dummy variable for employees working in East Germany.

5 | RESULTS

5.1 | Descriptive evidence

In Germany in the year 2017, full-time employed women earned on average 97.00 Euro per day and full-time employed men 118.54 Euro. On the basis of the difference of the log values, this corresponds to an unadjusted GPG of 20.1%. At the regional level, profound disparities emerge (see Figure 1).

Most notably, the unadjusted GPG is very low in East Germany, amounting to 5.5% as compared to 21.9% in the Western part. In six East German regions women even earn more than men: *Cottbus* (−4.3%), *Dessau-Rosslau* (−4.0%), *Frankfurt/Oder* (−3.6%), *Stendal* (−0.9%), *Schwerin* (−0.3%), and *Märkisch-Oderland* (−0.1%). In contrast, many regions in the South of Germany as well as in the Northwest exhibit a relatively high GPG. The highest GPG (40.3%) can be observed in the *Bodenseekreis* adjoining Austria and Switzerland. In the Southern districts of *Freudenstadt* and *Dingolfing-Landau* as well as in the city of *Ingolstadt* the GPG reaches values of around 38%.

The two regions with the highest and the lowest GPG feature marked differences between men and women (see Table A3 in the appendix). Most strikingly, men in the *Bodenseekreis* earn 1.7 times as much as men in *Cottbus*, whereas women's daily wages are of a quite similar range. One explanation might be the high share of high-qualified men in the *Bodenseekreis*, compared to *Cottbus*. What is more, the economic setting of the two regions provides different job opportunities for both men and women that seem to reinforce gender-specific occupational choices. In addition, the *Bodenseekreis* features a high share of large enterprises paying high wages and showing a high degree of wage dispersion.

Looking at the relationship between gendered wages and the GPG across all regions, it becomes evident that women's wages remain relatively stable, whereas men's wages are clearly higher in regions with a high GPG (see Figure S1 in supporting information). Only regions with a negative and very low GPG deviate slightly in that wages are relatively low for both genders. This pattern is confirmed by the correlation coefficient between male wages and the GPG that is much higher than for female wages (0.71 vs. 0.28). Obviously, men's wages drive the regional pattern of the GPG more than women's wages, further suggesting that factors which drive gendered wages are

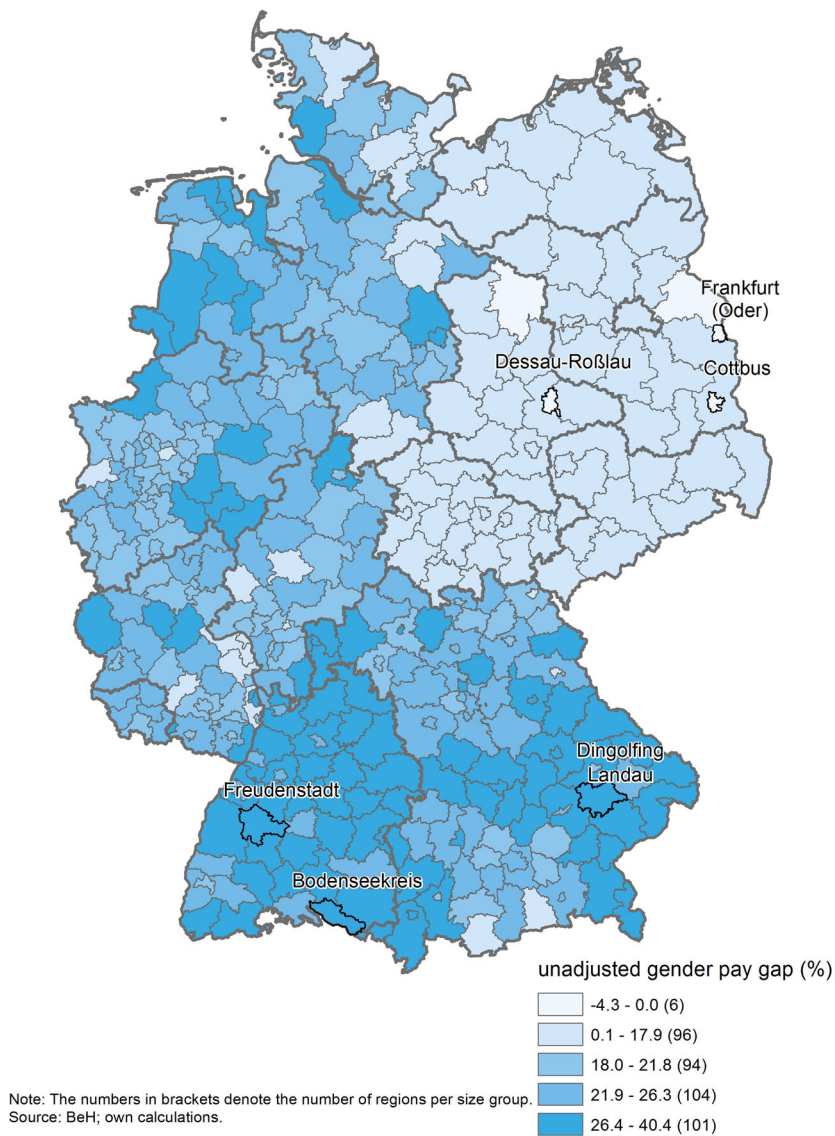


FIGURE 1 The unadjusted gender pay gap in German regions, 2017

distributed unequally between the regions. In the following, we will assess the reasons for the regional differences in the GPG with the help of the OB decomposition technique.

5.2 | Decomposition of the national gender pay gap

For Germany, results of the decomposition show that 6.9 percentage points or about 34.3% of the unadjusted gap of 20.1% can be traced back to gender differences in the explanatory factors included in our analysis, whereas 13.1 percentage points remain as the unexplained part (see Table A4 in the appendix).⁹ From the detailed



decomposition results it becomes clear that establishment characteristics play a prominent role in the explained part, contributing 7.1 percentage points to the overall GPG. Among these, gender differences working in favor of men's wages such as working in an establishment with a high share of female employees and working in a high-wage establishment are the prime factors (4.1 and 2.3 percentage points). In contrast, gender differences in individual characteristics that work in favor of women's wages contribute only a total of -0.7 percentage points to the overall gap. Our result that firm characteristics play a decisive role in explaining the GPG is in line with previous findings by Card et al. (2016).

Observed gender differences in specific regional characteristics contribute 0.4 percentage points to the GPG. However, this rather low overall contribution hides larger impacts of the single regional characteristics that partly offset each other. First of all, the descriptive evidence in Table A2 in the appendix documents that on average women work in denser labor markets than men. According to the decomposition results, this gender difference reduces the GPG, pointing towards larger benefits from agglomeration economies for women that are in line with previous findings (Bacolod, 2017; Hirsch et al., 2013; Nisic, 2017; Phimister, 2005). This cannot all be put down to the role of the service sector, as the decomposition results on its employment share indicate. On average, women rather work in regions with a slightly higher employment share in services, which increases the GPG by 0.2 percentage points. Similarly, the observation that women work in regions with a higher unemployment rate than men transmits into a slight increase of the GPG, hinting towards a higher bargaining power of establishments in regions with high unemployment and entailing lower wages, particularly for women. The largest regional effect comes from gender differences in working in East and West Germany, leading to an increase in the GPG of 0.3 percentage points. As evidenced in Figure 1, working in East Germany should reduce the GPG. However, it has to be kept in mind that the decomposition is conducted for the whole of Germany. As a consequence, we have to consider differences between men and women who work in East and West Germany, respectively.¹⁰ The positive impact of the East Dummy can then be traced back to the combination of the higher share of women working in East Germany and the significantly higher wages of men working in West Germany. Summarizing the role of the regional determinants, the decomposition shows a significant but small impact of the regional variables on the GPG.¹¹ This implies that other factors, particularly, individual and firm-specific characteristics that are unevenly distributed in space are responsible for the profound regional differences in the GPG. We, therefore, proceed with separate decompositions for each region to uncover any regional particularities in the individual and establishment-specific dimensions.

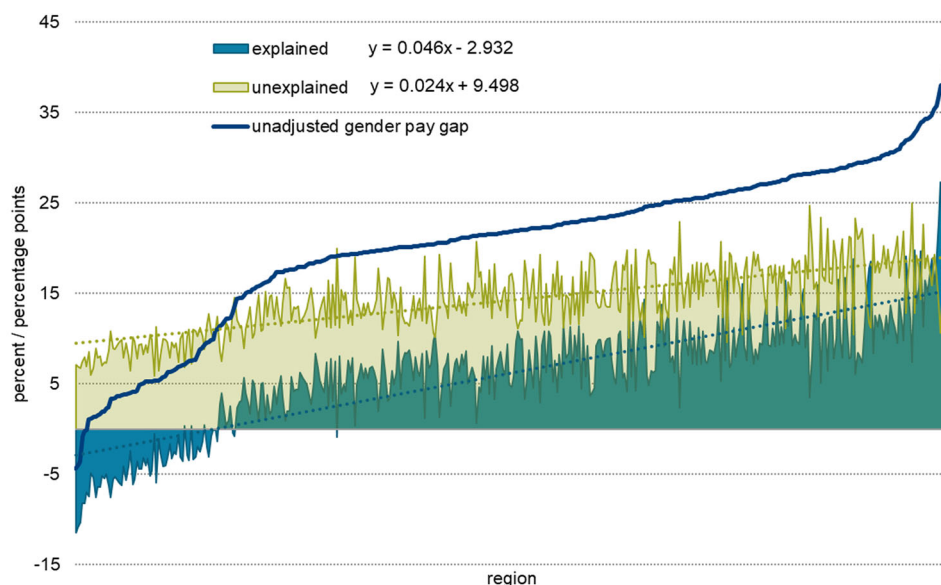
5.3 | Decomposition of the regional gender pay gaps

Figure 2 shows the variation of the explained and unexplained parts after the decompositions for the NUTS 3 regions in Germany, which are sorted by the magnitude of their unadjusted GPG. The linear trend lines sum up the coefficients of the two parts across the sorted regions, answering the question of how large the regional differences are with regard to the respective part. The steeper the slope, the more the regions differ. The trend line of the explained part has a positive slope (0.05), hinting towards regional disparities in the relevance of

⁹Given the data limitations that are unavoidable when analyzing the GPG, it is a general result for many countries that the explained part makes up the smaller share of the GPG (Boll et al., 2016; Murillo Huertas et al., 2017; OECD, 2017).

¹⁰14% of all men work in East Germany as compared to 16% of all women (see Table A2 in the appendix).

¹¹An OLS regression of the regional characteristics on the regional unadjusted GPGs yields a significant and negative correlation between the share of the service sector, the female employment rate, the regional unemployment rate, and the workplace in East Germany. Hence, low values in these determinants go along with a high GPG in a region.



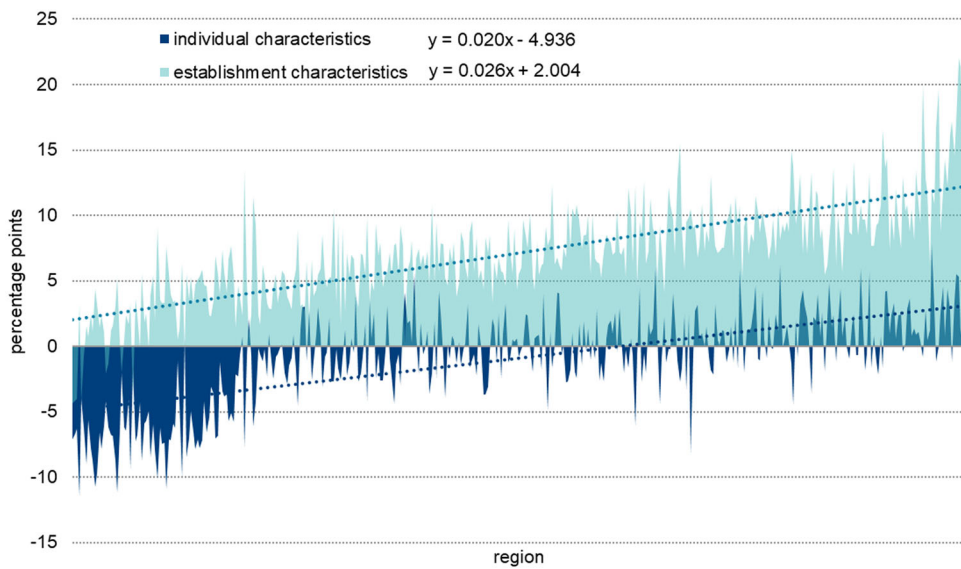
Note: The regions are sorted in increasing order of their GPG. The linear trend lines depict the generalized magnitude of the explained and unexplained part (y) in the sorted regions (x), respectively.
 Sources: BeH, IEB, BHP; own calculations.

FIGURE 2 Explained and unexplained part of the regional gender pay gaps

observed gender differences in wage determinants for explaining the GPG. In that sense, we observe that the explained part mitigates the GPG at the lower end of the regional GPG distribution and enlarges it at the upper end. In addition, the wage determinants have greater explanatory power in regions with either a high or a low GPG. In contrast to the explained part, the unexplained part is positive in all regions and points towards smaller but still significant regional differences, as is shown by the slope of the trend line (0.02).¹² These findings can again be concretized with the example of the two extreme regions. In *Cottbus*, the explained part amounts to -11.5 percentage points of the overall GPG of -4.3% (see Table A4 in the appendix). This means that women are actually better endowed than men in terms of observed wage determinants, which should translate into a female wage advantage of 11.5% percentage points. However, the unexplained part that consists of higher market returns for male workers on identical endowments of both genders, as well as the constant (see Equation 3), makes up 7.1 percentage points. It counteracts the explained part and leads to a smaller, but still existent wage advantage of women. In contrast, in the *Bodenseekreis* the explained part makes up 23.1 percentage points of the unadjusted GPG of 40.3%, assigning gender differences in observed wage determinants in favor of men a major role. In addition, the unexplained part amounts to 17.2 percentage points and thereby contributes to men's higher wages in the region as well.

Figure 2 further generalizes the exemplary findings for the two extreme regions by illustrating an increasing endowment advantage of men along with the GPG per region. As we outlined above that women's wages barely vary across regions, their endowments should neither vary. This, in turn, suggests that men's wage advantage in regions with a high GPG is driven by particularly high male endowments in these regions, compared to their peers in regions with a low GPG. This view complies with a negative explained part of the GPG in a total of 66 regions. Such a diversified spatial pattern is also observed by Murillo Huertas et al. (2017) for Spain.

¹²The positive slopes are also evident when using standardized values. In addition, the slope for the explained part is still larger than for the unexplained part. The standardized results are available upon request.



Note: The regions are sorted in increasing order of their GPG. The linear trend lines depict the generalized magnitude of the individual and establishment characteristics (y) in the sorted regions (x), respectively.
Sources: BeH, IEB, BHP; own calculations.

FIGURE 3 Decomposition of the explained part of the regional gender pay gaps

Further disentangling the explained part in Figure 3 makes clear that individual and establishment characteristics play different roles across the 401 regions. At the lower end of the regions, women have better-observed endowments in primarily individual characteristics, whereas the opposite is true at the upper end. In 11 regions, both individual and establishment characteristics reduce the GPG, whereas in 216 regions only gender differences in individual features are negative. The larger spatial differences in the impact of establishment factors can also be inferred from the slope of the trend line, which is slightly steeper along the regional GPG distribution than that of the individual factors (0.03 vs. 0.02). In only one region, men have better endowments in individual characteristics than women, but worse in establishment characteristics. In all other regions, both groups of characteristics point towards better-observed endowments of men in terms of wages, as can be seen in the *Bodenseekreis* (see Table A3 in the appendix).

Going one more step into detail, Figure 4 summarizes the contribution of each individual and establishment characteristic for the explained parts of the regional GPGs. For reasons of clarity, we present only the linear trend lines that indicate the respective spatial differences in the contribution of each variable to the GPG.¹³ Their stylized position with respect to the horizontal axis answers the question whether the impact of the variable changes its sign along the regional GPG distribution. If there is no intersection with the horizontal axis, the impact stays, in general, positive or negative across all regions.

The decomposition results in Figure 4 clearly state that nearly all explanatory characteristics differ in their impact on the GPG per region. The largest differences with respect to the impact on the regional GPGs can be ascribed to the wage level within the establishment. Here, the slope amounts to 1.65. The corresponding stylized diagram documents a negative impact in regions with a low GPG, that is, reducing the GPG that translates into a positive impact, that is, increasing the GPG in regions with a medium and high GPG.

¹³The level of significance of each explanatory factor in each region can be received upon request.

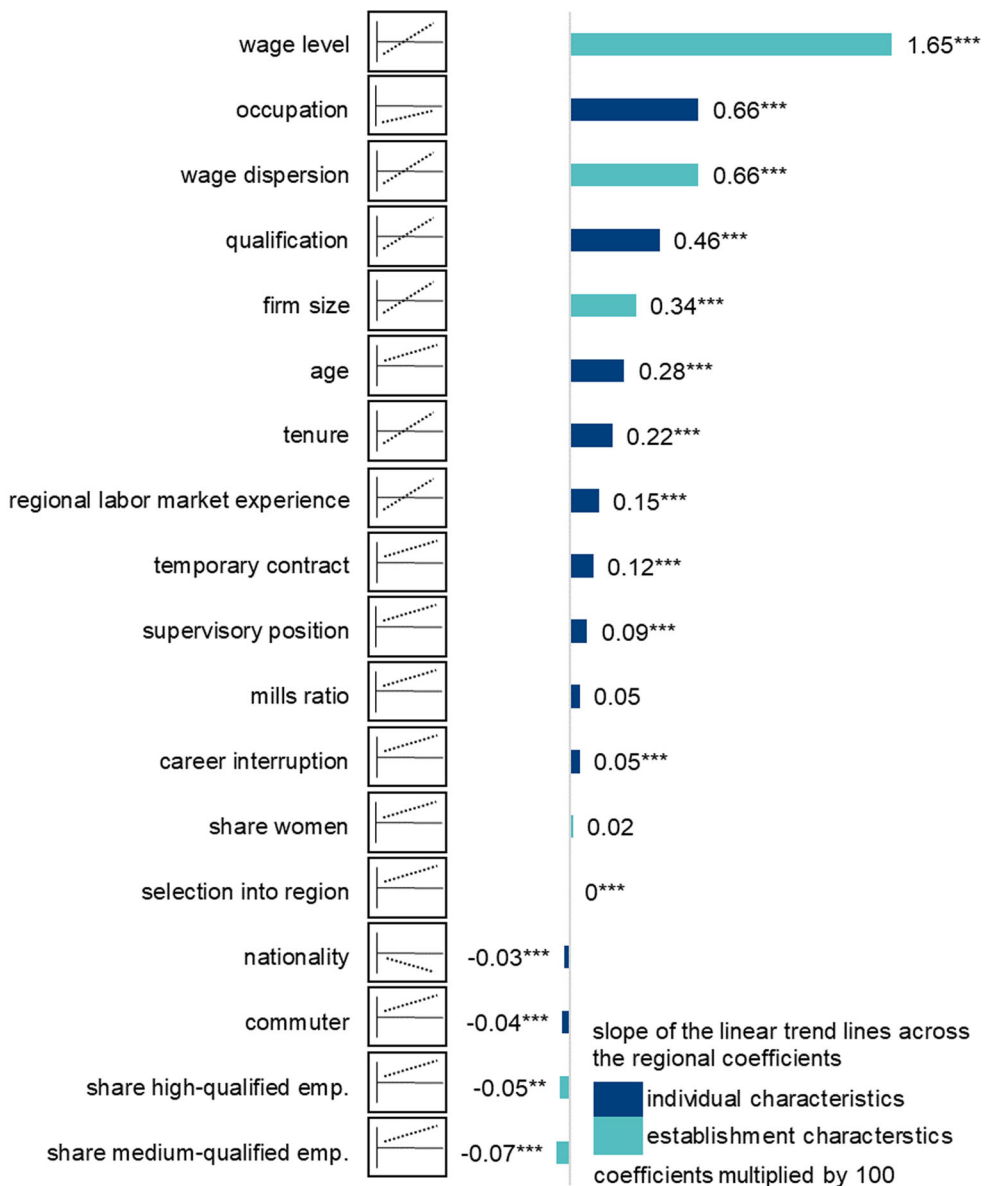
For example, in *Cottbus* gender differences in the wage level variable reduce the GPG by 5.8 percentage points, whereas in the *Bodenseekreis* they enhance the GPG by 4.4 percentage points (see Table A4 in the appendix). The latter result corresponds with the findings of other studies in that men sort into well-paid jobs within establishments (Barth et al., 2017; Card et al., 2016). Nonetheless, the negative impact in regions with a low GPG is rather contradictory. We interpret this not as a result of sorting, but rather of the absence of establishments paying high wages in these regions. This is specifically the case in East Germany, which still suffers from a weak economic structure.

A further factor that strongly shapes regional disparities in the GPG is gender differences in occupation. Obviously, in regions where women earn more or slightly less than men, women work in occupations that are relatively well paid and/or men tend to work in less well-paid occupations. Again, *Cottbus* and the *Bodenseekreis* serve as good examples. In *Cottbus*, driving vehicles in road traffic, which generally constitutes a relatively low-paid job, is the most common occupation among men, whereas most women hold well-paid occupations in public administration. In contrast, in the *Bodenseekreis* men rather exert well-paid machine-building occupations, whereas most women work as lower-paid office clerks and secretaries (see Table A3 in the appendix). These exemplary findings are generalized by the slope in Figure 4, which depicts spatial differences in the impact of occupational segregation on the regional GPGs. Profound regional variation in gender-specific occupation is also documented by Perales and Vidal (2015), who emphasize that work-related opportunities and outcomes are greatly influenced by the characteristics of the local labor market. Still, the impact is negative in all regions. At first sight, this result seems to contradict studies which argue that the gender-specific selection into occupations is one of the main reasons for gender differences in wages. However, as the occupational pattern in a region is strongly influenced by its sectoral composition (Perales & Vidal, 2015; Petrongolo & Ronchi, 2020), its strong impact on the regional GPG hints towards an equally strong impact of the regional economic structure. In fact, we find a very high correlation between occupations and sectors that leads to the overall negative impact of the occupational variable. Therefore, we conclude that it is not the choice of occupation, but the different distribution of occupations across the sectors that leads to a wage disadvantage for women. This conclusion is confirmed by the decomposition results for gender differences in working in establishments with a high share of female employees. As shown in Figure 4, the contribution of this variable to the GPG is positive throughout all regions, hinting towards a detrimental effect of sorting into female-dominated sectors for female wages.

Wage dispersion and establishment size are also of high relevance in explaining differences in the regional GPGs. Their impact is negative in regions with a low GPG and turns positive in regions with a high GPG. In the latter, the observed gender-specific sorting into high- and low-wage establishments is consistent with the findings of Arulampalam et al. (2007), Goldin et al. (2017), and Card et al. (2016), who conclude that men sort into higher-paying firms and benefit more from pay premiums in these firms. As many regions with a negative and low GPG are located in East Germany, one straightforward explanation might be provided by the small-scale establishment size structure that goes along with a lower level of wage dispersion.

Turning towards the effect of human capital, gender differences in qualification turn out to be most important. Again, they mitigate the GPG in regions on the bottom of the regional GPG distribution and increase it in regions at the top. This might reflect the generally higher level of formal qualification of East German women in particular that leads to higher wages (Minkus & Busch-Heinzmann, 2018). Similar positions and slopes of the trend lines emerge for tenure and for regional labor market experience.

Age, on the contrary, shows a positive and increasing relevance for the GPG along the regional GPG distribution, thus mirroring the results on the national level. Evidently, age, going along with labor market experience, is rewarded more for men than for women in monetary terms in all regions (Combet & Oetsch, 2019; Manning & Swaffield, 2008). The same holds for having a temporary contract that increases the GPG by putting pressure on women's wages regardless of the place of work (Boll et al., 2016). In the same vein, gender differences in holding a supervisory position increase the GPG throughout Germany, hinting towards the existence of a "glass ceiling" that prevents women from getting into top jobs. Finally, the impact of the inverse mills ratio



Note: The stylized diagrams depict the position and the slope of the linear trend lines of the respective variables across the sorted regions. *** significant at 1%-level, ** significant at 5%-level, * significant at 10%-level. Sources: BeH, IEB, BHP; own calculations.

FIGURE 4 Detailed results for the explained part of the regional gender pay gaps

that controls for the selection into employment does not significantly vary across regions, albeit its contribution is positive throughout.

Summarizing the results of the regional decompositions, we can conclude that the unambiguous impact of the factors that explain the GPG at the national level does not hold at the regional level. Importantly, the impact of most factors coincides with theoretical reasoning mainly in regions with a high GPG. Overall, we find profound

regional heterogeneity in the explanatory factors that are also documented for Spain (Murillo Huertas et al., 2017).

6 | ROBUSTNESS CHECKS

To check the validity of our results, we run several robustness checks whose graphical visualizations are depicted in Table S1 and Figures S2–S10 in Supporting Information.¹⁴ We start with the data restriction that the wages are right-censored and consequently exclude those employees whose wages exceed the social security contribution limit. The GPG decreases in most regions, which is consistent with the fact that the GPG is usually higher for high-income individuals (Fortin et al., 2017). However, only minor changes in the regional ranking emerge, and the patterns regarding the explained and unexplained part, as well as the contribution of the individual and establishment characteristics, remain largely unaffected. Related, we check whether the profound regional variation in the GPG is affected by outliers in wages by dropping the top and bottom 1% in the wage distribution for males and females. The regional GPGs slightly decrease again, with only minor changes in the regional ranking and underlying patterns. We conclude that wage restrictions do not seem to impair the validity of our results.

The second data restriction relates to missing information on the exact working time. To approximate biases that might arise from having excluded part-time employment, we need to calculate hourly wages for both full-time and part-time employees. We draw our assumptions on the actual number of hours worked from the Federal Statistical Office in Germany that is available as one broad measure across sectors and regions (Rengers et al., 2017).¹⁵ As a result, the regional GPGs decrease, with women featuring advantages in observed characteristics in more regions than before. Gender differences in working time are a major driver of this decrease in all regions. Although slight changes in the ranking of the regions with medium and low GPGs occur, the broad spatial pattern remains quite constant. In light of the rather coarse breakdown of working time on the individual employees irrespective of sectoral or regional affiliation, the results have to be taken with caution, however.

Another issue that calls for investigation is the robustness of the results against spatial biases that arise from individual mobility between the single regions. As more than one-third of the employees in our data commute between the place of living and the place of work (see Table A2 in the appendix), in a first step, we exclude commuters from the analysis. Only slight changes in the regional ranking and the underlying patterns occur. Second, we explicitly integrate commuting in our spatial delineation by aggregating the NUTS 3 regions to higher-level labor market regions (Kosfeld & Werner, 2012).¹⁶ Again, the regional picture remains quite constant. A slightly different form of individual mobility arises from the selection of employees into the region related to the current job. To this, we exclude employees who worked in another region before their current employment, which hardly affects the results (see also Hirsch et al., 2013). As these robustness checks bring along only slight deviations from the main results, we can conclude that spatial biases due to individual mobility are of minor importance in our analysis.

The last two robustness checks deal with the observation that the GPG differs across economic sectors. We, therefore, analyze the male-dominated manufacturing sector and the female-dominated public sector separately (OECD, 2017; Olivetti & Petrongolo, 2016). The GPG in manufacturing is nearly three times higher than in the

¹⁴Detailed results for each region can be provided upon request.

¹⁵In Germany, male full-time employees work 8.2 h/day and female full-time employees 7.9 h/day, whereas male part-time employees have a working time of 3.7 h/day and female part-time employees of 4.0 h/day (Rengers et al., 2017). We calculate hourly wages by dividing the daily wages by these figures.

¹⁶These 141 labor market regions comprise those NUTS 3 regions that are characterized by close commuter links between them. At the same time, they feature high seclusion toward other regional labor market regions so that mobility between them is put to a minimum.

public sector (see also Boll and Lagemann, 2018). In manufacturing as opposed to the public sector, observed gender differences in the sorting into firms play an even greater role than in the overall results. Furthermore, the ranking of the regions differs markedly. These results clearly corroborate our conclusions that economic opportunities in a region play a crucial role in explaining the regional disparities in the GPG.

7 | CONCLUSION

On the basis of detailed information on all full-time employees in Germany, this paper has presented new evidence on the magnitude and determinants of regional differences in the GPG. The nationwide unadjusted GPG of 20.1% in Germany hides a range of -4.3% to 40.3% on the level of the NUTS 3 regions. In a total of six regions in East Germany, women earn more than men. We have applied OB decompositions for Germany and its 401 NUTS 3 regions and considered individual, establishment, and regional determinants.

The decomposition of the national GPG has shown that gender differences in establishment characteristics play a crucial role in explaining the lower wages of women. In contrast, individual and regional characteristics exert a rather small impact. Nonetheless, the large spatial variation of the GPG has underscored the necessity to conduct decompositions at the regional level.

Separate decompositions for each region have highlighted the very different roles of the observed gender differences in both individual and establishment characteristics in regional respect and have uncovered profound regional disparities in employment opportunities for men and women. Importantly, men's wages drive the regional variation in the GPG much more than women's wages. Consequently, the results specifically emphasize the availability of well-paid jobs in male-dominated sectors as a central determinant of the regional GPG. This is the case for regions with a strong manufacturing base and large establishments like the *Bodenseekreis* or *Ingolstadt* in Southern Germany that feature a very high GPG. In contrast, men in regions with a negative or low GPG are worse off not only in comparison to women but even more so in comparison to men in regions with a high GPG. What is more, the endowment of male and female employees with individual human capital factors such as qualification, age, and work experience varies considerably across regions. This especially pertains to regions in East Germany like *Cottbus*, where women's individual employment biography pays off more than for their counterparts in West Germany.

Our results clearly emphasize that analyses at the national level come too short in precisely explaining the GPG. As the general determinants of the GPG, such as gender-specific occupational choice and sorting into establishments, vary in their explanatory power in regional respect, it seems essential to understand their interplay with the local employment opportunities to reduce the overall GPG. Hence, local policymakers have to be aware of regional particularities to reduce the GPG in their region.

The results of this article leave space for further research. Foremost, loosening the data restrictions with respect to the consideration of working hours and household constellations poses a worthwhile challenge, which we expect to provide further explanatory power for regional differences in the GPG. Last but not least, it would be very informative to conduct comparative analyses for further countries to uncover systematic patterns in the impact of gendered wage determinants in regional respect.

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CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the Institute for Employment Research. Restrictions apply to the availability of these data, which were used under license for this study. Data are available at <https://www.fdz.iab.de/> with the permission of the Institute for Employment Research.

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SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

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APPENDIX A

TABLE A1 Definition of the explanatory variables

Variable name	Definition
Individual characteristics	
Age	Dummy 1: 15–19 years, 2: 20–24 years, 3: 25–29 years, 4: 30–34 years, 5: 35–39 years, 6: 40–44 years, 7: 45–49 years, 8: 50–54 years, 9: 55–59 years, 10: 60–64 years
Qualification	Dummy 1: Low-qualified (no completed vocational training) 2: Medium-qualified (completed vocational training) 3: High-qualified (university degree)
Tenure	Number of days in employment in the current establishment
Career interruption	Share of the number of days neither in employment nor in unemployment on the total number of days in the last 20 years (%)
Temporary contract	Dummy 1: Yes, 0: No
Occupation	Occupation at the 3-digit level of the KldB 2010 (144 dummies)
Supervisory position	Dummy 1: Yes, 0: No
Nationality	Dummy 1: Foreign, 0: German
Commuter	Dummy 1: Place of work unequal to place of living, 0: Otherwise
Selection into region	Dummy 1: Change of place of work before 2017, 0: No change
Regional labor market experience	Share of the number of days in employment in the current region on the total number of days in employment in the last 20 years (%)
Mills ratio	Inverse mills ratio from a Probit model for employment
Establishment characteristics	
Establishment size (employees)	Dummy 1: <11, 2: 11–20, 3: 21–50, 4: 51–250, 5: >250
Share medium-qualified employees	Share of employees having completed vocational training on all employees (%)
Share high-qualified employees	Share of employees holding a university degree on all employees (%)
Wage level (€)	Median daily wage per establishment (dummy 1: <50, 2: 50–99, 3: 100–199, 4: 200–499, 5: >499)
Wage dispersion	Absolute deviation from establishment wage median in €
Share women	Share of women on all employees (%)
Regional characteristics	
Labor market density	Share of employees subject to social security contribution on all inhabitants per region in 2017 (%)
Share service sector	Share of employees subject to social security contribution in services on all employees per region (%)
Female employment rate	Share of female employees subject to social security contribution on all female inhabitants aged between 15 and 64 years per region in 2017 (%)

(Continues)

**TABLE A1** (Continued)

Variable name	Definition
Unemployment rate	Unemployment rate in 2017 (%)
Fertility rate	Number of live births per woman aged between 15 and 45 years in 2017
Religion	Share of inhabitants with Roman Catholic denomination on all inhabitants per region in 2017 (%)
East Germany	Dummy 1: Yes, 0: No

Source: Own compilation.

TABLE A2 Descriptive statistics for the explanatory variables, Germany 2017

Variable	Number of observations		Mean		Minimum	Maximum
	Men	Women	Men	Women		
Individual characteristics						
Age (years)						
15–19	12,255,108	5,678,261	0.00	0.00	0	1
20–24	12,255,108	5,678,261	0.04	0.06	0	1
25–29	12,255,108	5,678,261	0.09	0.14	0	1
30–34	12,255,108	5,678,261	0.12	0.13	0	1
35–39	12,255,108	5,678,261	0.12	0.10	0	1
40–44	12,255,108	5,678,261	0.11	0.09	0	1
45–49	12,255,108	5,678,261	0.14	0.12	0	1
50–54	12,255,108	5,678,261	0.16	0.15	0	1
55–59	12,255,108	5,678,261	0.13	0.13	0	1
60–64	12,255,108	5,678,261	0.07	0.07	0	1
Qualification						
Low	12,255,108	5,678,261	0.06	0.07	0	1
Medium	12,255,108	5,678,261	0.73	0.71	0	1
High	12,255,108	5,678,261	0.21	0.22	0	1
Tenure	12,255,108	5,678,261	2,629.8	2,413.5	1	6,575
Career interruption	12,255,108	5,678,261	6.09	7.62	0	95.55
Temporary contract	12,255,108	5,678,261	0.11	0.15	0	1
Supervisory position	12,255,108	5,678,261	0.05	0.03	0	1
Nationality	12,255,108	5,678,261	0.08	0.06	0	1
Commuter	12,255,108	5,678,261	0.45	0.39	0	1

TABLE A2 (Continued)

Variable	Number of observations		Mean		Minimum	Maximum
	Men	Women	Men	Women		
Selection into region	12,255,108	5,678,261	0.15	0.14	0	1
Regional labor market experience	12,255,108	5,678,261	51.50	50.85	0	99.98
<i>Establishment characteristics</i>						
Establishment size (employees)						
<11	12,255,108	5,678,261	0.09	0.11	0	1
11–20	12,255,108	5,678,261	0.09	0.10	0	1
21–50	12,255,108	5,678,261	0.15	0.15	0	1
51–250	12,255,108	5,678,261	0.31	0.30	0	1
>250	12,255,108	5,678,261	0.37	0.35	0	1
Share medium-qualified employees	12,255,108	5,678,261	68.57	65.44	0	100
Share high-qualified employees	12,255,108	5,678,261	18.76	22.18	0	100
Wage level (€)						
<50	12,255,108	5,678,261	0.01	0.02	0	1
50–99	12,255,108	5,678,261	0.38	0.42	0	1
100–199	12,255,108	5,678,261	0.56	0.52	0	1
200–499	12,255,108	5,678,261	0.05	0.04	0	1
>499	12,255,108	5,678,261	0.00	0.00	0	1
Wage dispersion	12,255,108	5,678,261	25.67	25.04	0	259.8
Share women	12,255,108	5,678,261	28.90	58.60	0	100
<i>Regional characteristics</i>						
Labor market density	12,255,108	5,678,261	438.92	446.32	157.13	1,522.63
Share service sector	12,255,108	5,678,261	69.89	72.04	42.08	69.26
Female employment rate	12,255,108	5,678,261	55.95	55.99	0	1
Unemployment rate	12,255,108	5,678,261	5.72	5.97	1.5	14
Fertility rate	12,255,108	5,678,261	1.62	1.61	37.96	92.38
Religion	12,255,108	5,678,261	30.51	28.52	1.66	87.76
East Germany	12,255,108	5,678,261	0.14	0.16	0	1

Sources: BeH, IEB, BHP, Federal Employment Agency, Federal Statistical Office; own calculations.



TABLE A3 Selected characteristics for Germany and the regions with the lowest and highest unadjusted gender pay gap

	Germany	Cottbus	Bodenseekreis
Daily wages (€): Men	118.54	89.70	150.06
Women	97.00	93.68	100.24
Average age: Men	44	45	43
Women	43	46	41
Share low-qualified employees (%): Men	6.2	2.6	5.0
Women	6.7	2.1	7.4
Share high-qualified employees (%): Men	20.6	21.9	30.6
Women	22.1	27.2	21.2
Tenure (days): Men	2,630	2,436	2,808
Women	2,413	2,970	2,178
Share of commuters (%): Men	45.2	51.8	29.6
Women	38.5	46.5	24.4
Share of establishments with >250 employees (%)	36.1	28.9	45.0
Top 3 occupations: Men (%)	<ol style="list-style-type: none"> 1. Occ. in machine-building and -operating (7.4) 2. Occ. in warehousing/ logistics, postal and other delivery services, cargo handling (6.2) 3. Occ. in business organization and strategy (5.5) 	<ol style="list-style-type: none"> 1. Driver of vehicles in road traffic (6.8) 2. Occ. in machine-building and -operating (5.1) 3. Occ. in business organization and strategy (5.0) 	<ol style="list-style-type: none"> 1. Occ. in machine-building and -operating (13.7) 2. Occ. in metalworking (6.7) 3. Occ. in business organization and strategy (6.9)
Top 3 occupations: Women (%)	<ol style="list-style-type: none"> 1. Office clerks and secretaries (11.8) 2. Occ. in business organization and strategy (7.8) 3. Occ. in education and social work, and pedagogic specialists in social care work (5.9) 	<ol style="list-style-type: none"> 1. Occ. in public administration (14.2) 2. Office clerks and secretaries (9.5) 3. Occ. in business organization and strategy (8.6) 	<ol style="list-style-type: none"> 1. Office clerks and secretaries (11.0) 2. Occ. in education and social work, and pedagogic specialists in social care work (6.5) 3. Occ. in business organization and strategy (5.0)

**TABLE A3** (Continued)

	Germany	Cottbus	Bodenseekreis
Share of employees in establishments with a median wage below 100 € (%)	40.5	53.9	27.8
Wage dispersion (€)	25.5	18.7	31.8

Sources: BeH, IEB, BHP; own calculations.

TABLE A4 Detailed decomposition results for the explained part of the gender pay gap (GPG) for Germany and the regions with the lowest and highest unadjusted GPG

	Germany	Cottbus	Bodenseekreis
Unadjusted GPG	20.05***	-4.33*	40.35***
Explained part	6.90***	-11.46***	23.11***
Individual characteristics	-0.70	-7.10	6.54
Age	0.88***	-0.10	1.47***
Qualification	-0.27***	-0.92**	2.09***
Tenure	0.27***	-0.75***	1.02***
Career interruption	0.19***	-0.04	0.18***
Temporary contract	0.35***	-0.07	0.84***
Occupation	-2.84***	-4.97***	-0.29
Supervisory position	0.46***	0.09	0.48***
Nationality	-0.09***	-0.03	-0.08
Commuter	0.25***	0.15***	0.06
Selection into region	0.01***	0.11*	0.04
Regional labor market experience	0.06***	-0.66***	0.62***
Mills ratio	0.03***	0.11	0.10
Establishment characteristics	7.11	-4.36	16.57
Establishment size	0.25***	0.17	1.77**
Share medium-qualified employees	0.17***	-0.62**	-0.13
Share high-qualified employees	-0.02	1.14***	0.63*
Wage level	2.26***	-5.84***	4.35***
Wage dispersion	0.39***	-2.93***	3.85***
Share women	4.07***	3.73***	6.11***
Regional characteristics	0.43		
Labor market density	-0.02***		

(Continues)

**TABLE A4** (Continued)

	Germany	Cottbus	Bodenseekreis
Share service sector	0.18***		
Female employment rate	-0.00		
Unemployment rate	0.06***		
Fertility rate	-0.02*		
Religion	0.02**		
East Germany	0.27***		
Unexplained part	13.15***	7.13***	17.24***

***Significant at the 1% level, **Significant at the 5% level, *Significant at the 10% level.

Sources: BeH, IEB, BHP, Federal Employment Agency, Federal Statistical Office; own calculations.