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**11|2019** Why do women earn more than men in some regions? Explaining regional differences in the gender pay gap in Germany

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## Abstract

This paper provides first-time evidence on the magnitude and determinants of regional differences in the gender pay gap (GPG) in Germany. Using a comprehensive data set of all full-time employees, we conduct Oaxaca-Blinder decompositions for Germany and its regions to explain the regional variation of the GPG with theory-based individual, job-related and regional characteristics. Our results provide several novel insights into the regional dimension of the GPG. First, men's wages are more strongly correlated with the regional GPG than those of women, indicating that their wages drive the regional variation in the GPG much more than the wages of women. Second, the decomposition results reveal pronounced differences in the impact of the individual and job-related characteristics between the regions. Whereas job-related characteristics are important in regions with a high GPG, individual characteristics rather come into play in regions with a low or negative GPG. The results underscore the role played by the establishment composition in a region and the kind of jobs provided for the regional GPG. Women earn more than men in regions with a weak local economic structure and the absence of large firms providing well-paid manufacturing jobs. In regions with a high GPG, in contrast, men usually benefit from such jobs. The third result relates to the validity of the theoretical determinants of the GPG in regional respect. In contrast to the clear-cut decomposition results at the national level, at the regional level their validity mainly applies to specific subsets of regions. We conclude that analyses at the national level come too short in precisely explaining the regional variation of the GPG.

## Zusammenfassung

Der vorliegende Beitrag liefert erstmalig Erkenntnisse zum Ausmaß der regionalen Unterschiede in der geschlechtsspezifischen Lohnlücke. Mit Hilfe von Daten zu allen Vollzeitbeschäftigten führen wir Zerlegungen der unbereinigten Lohnlücke für Deutschland durch und erklären mit theoriebasierten individuellen, betriebsbezogenen und regionalen Charakteristika die regionalen Unterschiede in der Lohnlücke. Der Einfluss dieser Faktoren variiert sehr stark zwischen den Regionen. Während betriebsbezogene Faktoren insbesondere in Regionen mit einer hohen Lohnlücke wichtig sind, spielen individuelle Eigenschaften vor allem in Regionen mit einer negativen oder leicht positiven Lücke eine Rolle. Unsere Ergebnisse unterstreichen die hohe Relevanz der vor Ort ansässigen Unternehmen und daraus folgend der angebotenen Arbeitsplätze bei der Erklärung der regionalen Unterschiede in der Lohnlücke. Frauen verdienen in solchen Regionen mehr, in denen es eine eher schwache ökonomische Basis gibt. In diesen Regionen fehlen oftmals Großbetriebe mit gut bezahlten Arbeitsplätzen in der Industrie, von denen Männer in Regionen mit einer hohen Lohnlücke profitieren.

## JEL-Classification

J31, R23, J16

## Keywords

Decomposition, gender pay gap, regional labor markets

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# 1 Introduction

Research on the gender pay gap (GPG) meanwhile looks back on a long tradition. A vast theoretical and empirical body of literature has uncovered multifaceted causes of the GPG ranging from gender differences in education and labor market experience as well as in occupational and sectoral choice to the impact of gender roles and non-cognitive skills (see Olivetti/Petrongolo 2016; Blau/Kahn 2017 or Kunze 2017 for detailed overviews). In light of the persistent wage differences between men and women in many industrialized countries (OECD 2017), this research remains highly important.

One aspect of the GPG that has received only very little attention so far pertains to its regional dimension. Empirical studies mostly focus on the national level (Blau/Kahn 2003, 2017; Card/Cardoso/Kline 2016; Olivetti/Petrongolo 2016; Barth/Kerr/Olivetti 2017). However, the GPG varies considerably within a country. In Germany, the unadjusted GPG for full-time employees ranges between -4.3 % and 41.4 % in the NUTS3-regions, highlighting that in some regions women even earn more than men. Surprisingly, little is known about the mechanisms that drive these profound regional disparities of the GPG. The few existing studies on regional aspects of the GPG mainly focus on gender differences between rural and urban regions, ascertaining a lower GPG in cities (Glæser/Maré 2001; Phimister 2005; Hirsch/König/Möller 2013; Bacolod 2017). General and comprehensive evidence on regional gender wage disparities is largely missing, which might mainly be due to data availability.

A fundamental question that arises in regional respect is to what extent gender-specific wage differences not only depend on the determinants found to be relevant at the national level, but also on factors that are inherent in the single regions. In close relation is the question if and to what degree the theoretical arguments and driving factors that explain the GPG at the national level also hold at the sub-national level. Regions differ substantially in their sectoral composition, thus providing different employment possibilities for men and women (Hanson/Pratt 1995; Perales/Vidal 2015; Olivetti/Petrongolo 2016). Regional disparities are further enhanced by compositional differences in workers' characteristics across regions (Yeandle 2009). Consequently, the influence of the determinants of the national GPG should also be distributed unevenly at the regional level. In light of the vast regional labor market disparities in many countries (OECD 2005), research on these questions is of major importance.

This paper provides first-time answers to the questions posed above by explaining the regional variation of the GPG within Germany with individual, establishment and regional characteristics. Germany provides a particularly interesting example, because regional disparities on the labor market are as striking as they are persistent (OECD 2005). Our contribution is threefold. First, we scrutinize at the national level the role of regional characteristics that we consider in addition to the commonly used driving factors of the GPG. This way, we identify the role of region-specific factors as compared to individual and establishment determinants. Second, we examine at the regional level the impact of the factors that drive the GPG at the national level and how this impact differs across the regions. Third, we add a regional dimension to the theoretical approaches to the GPG by investigating if they are valid across all regions or only for specific groups of regions.

Our analysis rests on comprehensive data for the year 2016 that provides detailed information on all employees covered by the German social security system, including daily wages and the place of work. The total sample consists of roughly 18 million full-time employees. We follow the seminal work of Oaxaca (1973) and Blinder (1973) and decompose the unadjusted GPG into an explained and unexplained part for Germany as well as for all 401 NUTS3-regions. The explanatory factors comprise individual, establishment and regional determinants that are derived from approaches of human capital and segmented labor market theories, enriched by arguments from regional science.

Our results provide novel insights into the regional dimension of the GPG. Importantly, observed individual and establishment characteristics play very different roles across the regions, featuring a higher explanatory power in regions with either a low or high GPG. In most regions with a low or negative GPG, gender differences in individual features are more important than establishment factors. Establishment factors, on the other side, tend to be more important in regions with a high GPG. In addition, the impact of some characteristics that holds at the national level is mostly valid in regions with a high GPG and often changes its sign along the regional GPG distribution. Overall, our findings ascribe a higher impact to factors rooted in segmented labor market theories than in approaches of human capital. However, both theoretical approaches explain gender differences in wages mainly in regions with a high GPG. These findings reflect the very different establishment structure of the German regions, highlighting the provision of highly remunerated jobs in high-wage establishments dominated by men as a central driving force for a high regional GPG. Simultaneously, in regions where women earn more than men as evidenced by the unadjusted GPG, such jobs are largely absent, giving way to individual characteristics that boost the wages of women. However, in those regions as well, women earn less than men if they work within the same establishment and feature similar individual characteristics, such as occupation, age, tenure, or career interruptions.

The paper is organised as follows. Section 2 reviews the theoretical background and related empirical literature. In section 3, we describe the data and our research design. Section 4 discusses the results of the decomposition analyses for Germany and the single regions, and section 5 concludes.

## 2 Theoretical background and related literature

Among the most intensively investigated driving factors of the GPG are gender differences in the accumulation of human capital. According to human capital theory (Becker 1964), lower wages are ascribed to lower productivity, which is due to lower human capital investments. Human capital comprises knowledge and skills acquired mostly through formal education. It has been argued that women tend to invest less in education than men, as they anticipate future family-related career interruptions (Polachek 1981; Goldin/Polachek 1987). Hence, women might more likely be subject to a lower accumulation of human capital and therefore to lower wages compared to their male counterparts. However, women meanwhile perform better in educational attainment, at least in the OECD countries (OECD 2018).

Another aspect of human capital formation that might be of higher relevance for gender differences in wages relates to work experience. While it generally increases with age, women experience a devaluation of their human capital that is caused by a temporary absence from the labor market due to childbirth and ensuing childcare (Becker 1964; Light/Ureta 1995; Fitzenberger/Sommerfeld/Steffes 2013). This is consistent with findings that male and female wages are similar at the entry into the labor market, with gender differences evolving during the early career (Manning/Swaffield 2008; Bertrand/Goldin/Katz 2010). Concerning married couples, Goldin et al. (2017) conclude that family responsibilities tend to limit women's career choices with respect to job-to-job changes and identify this as an important determinant of the widening of the GPG. This is especially true for college-educated women who are more likely to be in occupations with steep age-earnings profiles. Empirical studies that specifically explore the wage penalty due to parental leave quantify the resulting wage losses between 10 % and 20 % (Ondrich et al. 2003; Ejrnæs/Kunze 2013). Focussing on West Germany, Gangl/Ziefle (2009) find a higher wage penalty than in the U.S. and Great Britain, which cannot be explained by mothers' observable labor market behavior. Hence, statistical discrimination against mothers might be even more pronounced in West Germany than in other countries. Although there are still differences between women in East and West Germany with respect to labor force participation and career interruptions due to child birth (Hanel/Riphahn 2012), they do not translate into different wage penalties. This result is corroborated by Schmelzer/Kurz/Schulze (2015), who additionally highlight that women in both parts of Germany earn significantly less when the career interruption exceeds the legally defined and publicly financed leave of absence.

A further factor that restricts the acquisition of work experience for women is the number of hours worked. Since part-time employment is much more widespread among women than among men, they accumulate less work experience. This might result in different hourly wages in full- and part-time jobs for women (Manning/Petrongolo 2008), but also hinder future progression on the career ladder and further wage gains in line with the human capital model (Kunze 2017). Moreover, the kind of employment contract matters, specifically holding a temporary contract (Booth/Francesconi/Frank 2002). Temporary workers have fewer incentives to accumulate job-specific human capital, because they risk a depreciation when the contract is not prolonged. For the same reason, employers are less willing to provide access to internal training. Because temporary positions are more frequently held by women than by men<sup>1</sup>, their existence not only contributes to lower wages in general, but presses down the wages of women in particular (Simón 2012; Boll et al. 2016).

Next to gender differences in human capital formation and work experience, segmented labor markets play a decisive role in explaining the GPG. One driving factor are self-selection processes. Women tend to choose different fields of professional education and study (Bertrand/Goldin/Katz 2010; Buffington et al. 2016) and consequently different occupations than men (Fitzenberger/Kunze 2005; Kunze 2005). The occupational decision is generally taken at a young age, with interests and personal preferences probably being more influential than the consideration of future wages. This behaviour might unconsciously be channelled into different (entry) jobs (Polachek 1981). This contributes to gender differences in wages, because women tend to work in low-

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<sup>1</sup> In 2017, 48 % of all newly employed women had a temporary contract, but only 41 % of all newly employed men (<https://statistik.arbeitsagentur.de/Statischer-Content/Grundlagen/Methodenberichte/Beschaeftigungsstatistik/Generische-Publikationen/Methodenbericht-Befristete-Beschaefigung.pdf>, accessed 05.04.2019).

paid occupations and men in more high-paid occupations (England 1992; Kunze 2017; Zucco 2019). For example, women often acquire professions in the field of caring and nursing, which are generally characterized by a lower pay than typical 'male' jobs and thereby contribute to a gender differential on earnings (Marini 1989; Datta Gupta/Rothstein 2005). Additional driving factors for taking up traditional 'female' occupations are social norms and traditional gender roles that might inflict high costs on those women who seek to escape them (Cooke 2006; Blau/Kahn 2017). One example of social norms that generally form attitudes towards gender equality are religious beliefs (Seguino 2011; Wiseman/Dutta 2016).

Gender differences in the sorting into firms constitute a second aspect of segmented labor markets. Research focusing on firm-specific wage-setting and pay policies shows that women are more likely to be employed in low-wage firms than men, which increases the GPG (Card/Cardoso/Kline 2016; Barth/Kerr/Olivetti 2017; Hara 2018). Card/Cardoso/Kline (2016) explain this additional burden on female wages by a combination of sorting and individual bargaining effects in that women are less likely to work in firms that pay higher premiums to either sex, and they receive a smaller share of the firm-specific pay premiums earned by men. The resulting earnings growth of men and women further differs according to career paths within or between establishments and educational background (Barth/Kerr/Olivetti 2017). Related with the sorting effect, pay-attractive jobs might be offered on gender-specific internal labor markets only (Doeringer/Piore 1971; Blau/Ferber 1986) that typically exist in larger establishments (Oi/Idson 1999). Consequently, women are less likely to hold a supervisory position that might push them through existing 'glass ceilings' within establishments. This is consistent with the observation that the GPG increases along the wage distribution of men and women (Arulampalam/Booth/Bryan 2007; Hara 2018). The consequences of the under-representation of women in top jobs are considerable, since this accounts for a substantial share of the GPG (Fortin/Bell/Böhm 2017).

Human capital and segmented labor market approaches provide insights into factors that drive wage differences between men and women in a country or in a selected group of countries. When analyzing differences in the GPG at the sub-national level, special features of the single regions have to be considered as well. For example, individual skills are not evenly distributed across locations (Combes/Gobillon 2015), bringing along differing consequences for men and women. One reason can be the existence of agglomeration effects. They increase productivity and hence wages by improving the quantity and quality of matches between workers and firms in dense and urban labor markets (Glaeser/Maré 2001). This urban wage premium affects men and women in different ways, and several reasons are responsible for the resulting lower GPG in cities (Phimister 2005; Hirsch/König/Möller 2013; Bacolod 2017; Nisic 2017). Because of their more fragmented employment histories, women might particularly benefit from improved urban job matching in a special way. Hence, they may experience a lower wage depreciation resulting from time out of employment than women in more rural areas (Phimister 2005). Relatedly, agglomerative forces should lead to a 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 (Gordon/Kumar/Richardson 1989; Crane 2007; Nisic 2017). 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 women (Hirsch/König/Möller 2013).

In addition to gender differences in agglomeration economies and mobility, regional disparities in the GPG might also result from differences in the local demand for occupations and tasks. Because each region features its own mix of specific industries and firms requiring specific occupations, local employment opportunities are profoundly different for men and women (Hanson/Pratt 1995). What is more, women usually predominate in public and hospitality services and men in the manufacturing and construction industries (Olivetti/Petrongolo 2016; OECD 2017). Hence, occupational segregation should be larger in regions where employment is concentrated in occupations that tend to be heavily female- or male-dominated (Perales/Vidal 2015). The impact of the local labor market structure on gendered wages is further enhanced by compositional differences in workers' characteristics across regions (Yeandle 2009). Consequently, the determinants that influence the GPG in general terms should also be distributed unevenly at the regional level.

Apart from solely economic factors, regional differences in social norms and traditions that can be traced back to religiosity might also contribute to the spatial variation of the GPG. This is of special relevance for Germany, because in addition to the spatially uneven distribution of Catholics and Protestants, there are also pronounced differences between East and West Germany.<sup>2</sup> In regions where especially the Catholic belief is widespread, e. g. in Bavaria, Saarland and regions in North-west Germany, the traditional division of labour and male breadwinner roles are likely to be reinforced. Therefore, in those regions the GPG should be higher than in regions with lower religious attachment (Cooke 2006; Wiseman/Dutta 2016).

Summing up, there are several theoretical arguments that explain why women earn less than men in general and why there should be regional differences in the GPG. As a conclusion, we expect the GPG to be higher in regions in which

1. men have a better endowment with respect to individual human capital factors, such as qualification, age, and work experience than women,
2. the regional economic structure that forms the basis for labor market segregation favors men, specifically providing jobs in manufacturing and featuring large establishments that pay high wages and enable internal career paths,
3. the local supply of jobs is sparse, entailing a low impact of agglomeration economies and the necessity to commute to urban centers.

In the following, we will empirically investigate the relevance of these three groups of theoretical impact factors for explaining the regional differences in the GPG.

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<sup>2</sup> Catholicism and Protestantism are the two major denominations in Germany. See <https://ergebnisse.zensus2011.de/#Map-Content:00.D1>, for a visualization at the level of the NUTS-2 regions. Whereas East Germany was a socialistic state with a discouragement of religious attendance and with an egalitarian notion between women and men, West Germany had a democratic system with a welfare system that supported male breadwinners and incorporated religious conceptions (Cooke 2006).

## 3 Research design

### 3.1 Data

Our main dataset is the Employee History (BeH) of the Institute of Employment Research (IAB) that covers all employment notifications in Germany.<sup>3</sup> For each person in employment subject to social security or in marginal employment, the BeH contains a detailed set of personal characteristics (e. g., gender, age, education, or place of residence) and his/her employment (gross wages, establishment identification number, occupational status, current occupation). For the respective establishments, information on their location and branch of industry is also included. The social insurance procedure compels employers to regularly report all changes that have occurred in the number of workers who are subject to health or unemployment insurance or who participate in a pension scheme. As they are not covered by social security, civil servants, persons in military service or self-employed are excluded. Due to legal sanctions for misreporting, the data is very reliable.

The BeH brings along the decisive advantage of providing fully representative data in regional perspective. However, our analysis underlies several restrictions that arise from the specific collection purpose. First, the wages are right-censored, because they have to be reported only up to the contribution limit of the social security in Germany. Therefore, we use the imputation procedure by Gartner (2005) to estimate the wages above the contribution limit.<sup>4</sup> Second, the German social security data does not contain information on the exact number of hours worked. This imposes a major restriction for our purposes, because it is not possible to construct hourly wages in an accurate way. Hence, we cannot compare part- and full-time employees. From a more theoretical point of view, we thus deliberately exclude one important source for gender differences in earnings that rests on lower wages for part-time employment (Boll et al. 2016; Manning/Petrongolo 2008). Furthermore, when comparing full-time employed men and women, it has to be taken into account that 84 % of the men in our data work full-time, but only 45 % of the women. We therefore have to control for the lower sorting of women into full-time employment (Olivetti/Petrongolo 2008; Blau/Kahn 2017). To this, we estimate the mills ratio from a probit model of being in full-time employment and include it as explanatory variable. The mills ratio quantifies the probability of being in full-time employment given the characteristics of each person.

One further drawback of the BeH for our purposes is its lack of information on the individuals' household situation. Hence, we cannot directly control for marital status and the number of children, as is often done in studies using survey data (e. g., Fitzenberger/Sommerfeld/Steffes 2013; Blau/Kahn 2017). In order to reduce this omitted variable problem, we make use of the Integrated Employment Biographies (IEB) of the IAB.<sup>5</sup> The IEB contains information on employment spells,

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<sup>3</sup> For more information on the BeH, see Schmucker et al. (2018). They provide a detailed description of the Establishment History Panel, which is compiled from the BeH.

<sup>4</sup> The contribution limit of the social security is fixed every year separately for East and West Germany. In 2016, it was 6.200 Euro per month in West Germany and 5.400 Euro in East Germany. 9 % of the employees in our dataset have wages above these thresholds. For the imputation, we estimate the wages with a tobit regression and explanatory variables for human capital and sector separately for men and women in East and West Germany. Decomposition results without censored wages can be found in section 4.2.3

<sup>5</sup> For more detailed information on the IEB see Antoni/Ganzer/vom Berge (2016), who provide a description of the Sample of the Integrated Labour Market Biographies, a 2 percent random sample of the IEB.

benefit receipts, participation in measures of active labor market policy, and job-search status for every person on a daily basis. We use this information for the construction of three variables that are based on individual labor market biographies.

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. We further use data from the Federal Employment Agency on the unemployment rate, the German Statistical Office on population and the micro-census 2011<sup>6</sup> on persons with Catholic denomination for the construction of some regional variables. The regional dimension of our analysis is delineated along the 401 NUTS 3-regions covering *kreisfreie Städte* and *Landkreise*.

The BeH for 2016 encompasses about 34.9 million employees that we confine to full-time employees only. We further disregard apprentices and persons with missing information on wages and restrict our data to full-time employees between 15 and 64 years of age. Our final data set encompasses 17,861,493 observations, of which are roughly 12.1 million men and 5.7 million women.

## 3.2 Variables

Our focus in this paper is on the GPG per region. It is based on the log 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 NUTS3-region in Germany as of June 30, 2016. We calculate the regional GPG as the difference between the log average wages of men and women per region.

We derive our explanatory variables from the theoretical considerations outlined in section 2, covering determinants of the GPG at the individual, establishment, and regional level. They are depicted in Table 1 along with their basis in human capital theory, segmented labor markets, and regional aspects considered particularly in regional science. We include some explanatory variables that cannot explicitly be assigned to the three theoretical lines as controls. Table A 1 in the Appendix contains the detailed definitions of all explanatory variables, and Table A 2 presents descriptive statistics for Germany.

Most of the individual characteristics relate to human capital approaches. We include the employees' age assigned to ten categories. Formal qualification is measured by a categorical variable that indicates whether the individual is low-, medium- or high-qualified.<sup>7</sup> Since an important determinant of women's lower wages is their lower labor market experience, we make use of the individuals' employment histories for its measurement (see also Kunze 2005). This allows us to take account of the returns of human capital along two different dimensions.<sup>8</sup> First, firm-specific labor market experience or tenure denotes the number of days at the current establishment. Second, we control for career interruptions by means of the share of the number of days the individual was neither in employment nor in unemployment on the total number of days in the last 20 years. This way, we indirectly include parental leaves which are likely to take up a large part of the career

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<sup>6</sup> The micro-census is the largest representative survey on the economic and social situation of German households. See <https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bevoelkerung/Haushalte-Familien/Methoden/mikrozensus.html> for further information.

<sup>7</sup> Due to missing information, we impute information on formal qualification based on the procedure of Fitzenberger/Osokominu/Völter (2006).

<sup>8</sup> We do not include general labor experience because of its high correlation with age and career interruptions.

interruptions of women and induce an additional wage penalty. Another job characteristic that affects wages relates to its duration, which we take into consideration by the existence of a temporary contract. The impact of the differing occupational choices of men and women is depicted by dummies for occupations at the 3-digit level of the German Classification of Occupations 2010 (*KldB 2010*).<sup>9</sup> We further control for obtaining a supervisory position, which might be relevant with respect to the existence of a ‘glass ceiling’ for women in leading positions.<sup>10</sup>

**Table 1: Explanatory variables and theoretical approaches**

Explanatory variables	Theoretical approaches			Control variables
	Human capital	Segmented labor markets	Regional science	
<b>Individual characteristics</b>				
Age	x			
Qualification	x			
Tenure	x			
Career interruption	x			
Temporary contract	x			
Occupation		x		
Supervisory position		x		
Selection into employment				x
Nationality				x
Commuter				x
Selection into region				x
Regional labor market experience				x
<b>Establishment characteristics</b>				
Establishment size		x		
Share medium-qualified employees		x		
Share high-qualified employees		x		
Wage level		x		
Wage dispersion		x		
<b>Regional characteristics</b>				
Labor market density			x	
Establishment size structure			x	
Unemployment rate				x
Religion				x
East Germany				x
Region fixed effects				x

Source: own compilation.

<sup>9</sup> Due to the high degree of collinearity between occupations and sectors, we only include occupations in our models.

<sup>10</sup> These positions involve a high degree of complexity and require a high level of expertise. The tasks comprise leading large enterprises and offices, organizing work processes, production and marketing and guiding employees (e.g., heads of departments, directors, managers, or headmasters).

Control variables at the individual level comprise a dummy variable on nationality and three variables covering the selection into regions and the interregional mobility of workers. Whereas this aspect plays no role in analyses on the national level, it is of high importance when considering regional labor markets that are closely interconnected via dense interregional commuting patterns. Because men feature a higher mobility than women, they might benefit more from better jobs which they have to commute or move for. First, we include a dummy for commuters who live outside the region of work under consideration. The effect should be high in rural or less dense labour market and low in urban labour markets. Second, we specifically control for the selection into the region related to the current job, i. e. whether a person changed the place of work specifically for the job obtained in 2016. To this, we calculate a dummy that indicates whether an individual worked in another region prior to her current employment. Third, we take into account regional labor market experience by including the share of days a person has been working in the specific region under consideration in the last 20 years.

The establishment variables capture characteristics that have a gender-specific impact on wages due to the different sorting into firms. Establishment size is taken into account by five size groups. We also include information on the workforce's qualification structure within the establishment to account for human capital intensity at the establishment level. To this, we calculate the share of medium- and high-skilled employees per establishment. Finally, the wage level and the wage dispersion within the establishment serve as a proxy for a high-wage or a low-wage establishment and the provision of high-paid jobs, taking into consideration the sorting of men and women into different establishments and jobs.

Finally, we include regional characteristics. First of all, we capture global agglomeration effects by labor market density, which additionally serves as a proxy for the thickness of the labor market. The regional establishment size structure comprises information on the share of small and large firms in a region, taking up the aforementioned fact that larger firms pay higher wages in a certain region. If a region is characterized by large firms, men are assumed to have greater advantages in job perspectives than women due to establishment sorting that result in higher wages and consequently in a higher regional GPG. Among the regional control variables, the unemployment rate characterizes the situation on the local labor market. Further, religious attachment captures traditional behavior and notions. To this, we control for the share of persons with Catholic denomination per region. Any specific characteristics in East Germany are taken into account by a dummy variable for employees working in East Germany<sup>11</sup>, and regional fixed effects capture statistically unobserved heterogeneity in the regions.

### 3.3 Empirical strategy

In assessing the impact of the local environment on the GPG, we follow the seminal work of Oaxaca (1973) and Blinder (1973) that has been widely used in subsequent wage gap studies (Fortin/Lemieux/Firpo 2011). The classic 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

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<sup>11</sup> The East German labor market still differs in some respects from the West German one. For example, with respect to wages Riphahn/Schnitzlein (2016) document a very strong decrease in wage mobility in East Germany, which might be indicative of a labor market with limited upward potential that especially affects male wages.

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-related 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  $\beta^j$  representing the estimated coefficient of the characteristic indexed by  $j$ , the region under consideration characterized by  $r$ , and  $\varepsilon$  denoting a residual term:

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

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

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 by the right-hand side regression results of the two equations above. 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 GPG is thus split into two components. The first component represents the part of the GPG attributable to gender differences in observed endowments. It is therefore termed the explained part. The second component is called the unexplained part 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.

We first conduct the OB-decomposition of the GPG at the national level in order to determine the main general impact factors and the role of specific regional characteristics. Second, we decompose the GPG for each of the 401 regions separately to specify in how far the forces found to play an important role in Germany as a total vary on the regional level.

## 4 Results

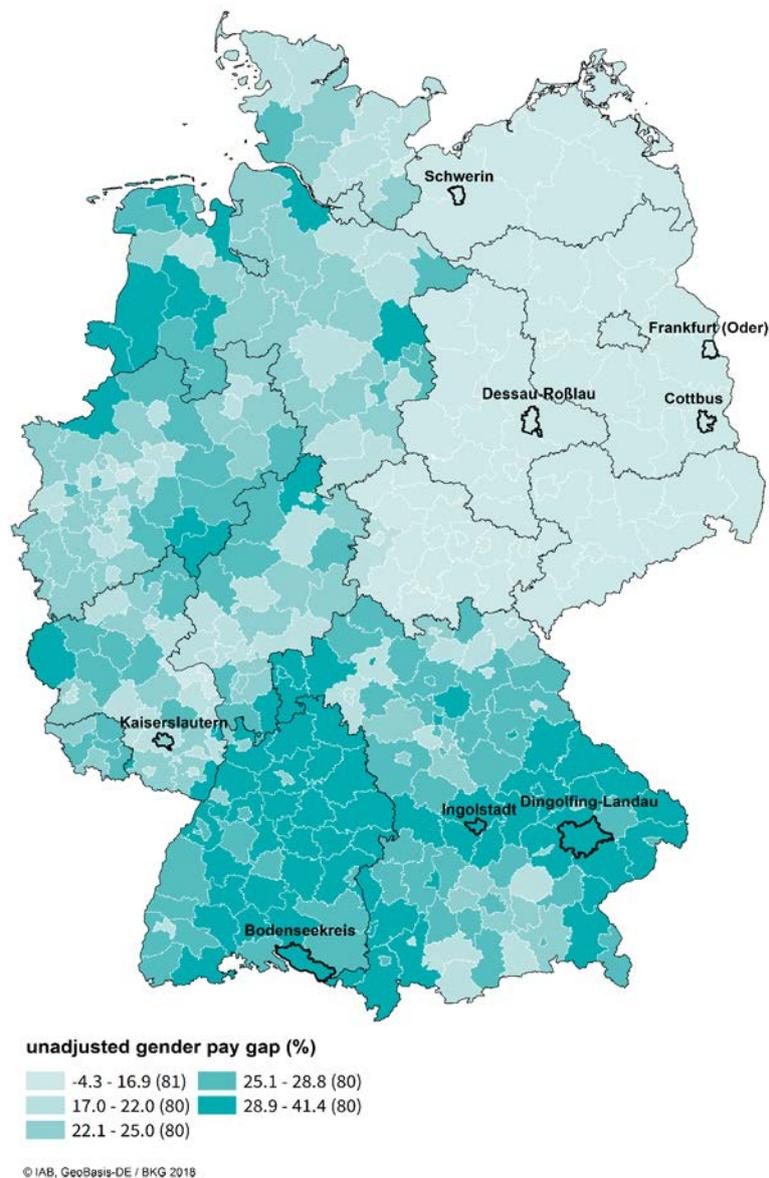
### 4.1 Descriptive evidence

In Germany, full-time employed women earned on average 92.21 Euro per day and full-time employed men 114.22 Euro in the year 2016. Based on the difference of the log values, this corresponds to a GPG of 21.4 %.<sup>12</sup> Kunze (2017) and OECD (2017) report similar values and additionally highlight the large gender differences in wages in Germany compared to other industrialized countries.

<sup>12</sup> The corresponding log values are 4.52 for women and 4.74 for men.

At the regional level, profound differences in the GPG emerge (see Figure 1). Most notably, the GPG is very low in East Germany, amounting to 6.2 % as compared to 23.4 % in the Western part of the country. In four East German regions women even earn more than men: In the city of *Cottbus* the GPG reaches -4.3 %, in *Frankfurt/Oder* -3.2 %, in *Dessau-Roßlau* -2.8 %, and in *Schwerin* -0.5 %. In contrast, many regions in the South of Germany as well as the regions in the Northwest exhibit a relatively high GPG. The highest GPG (41.4 %) can be observed in the *Bodenseekreis* adjoining Austria and Switzerland, in the city of *Ingolstadt* (40.6 %) and in the district *Dingolfing-Landau* (40.2 %, both in the state of Bavaria).

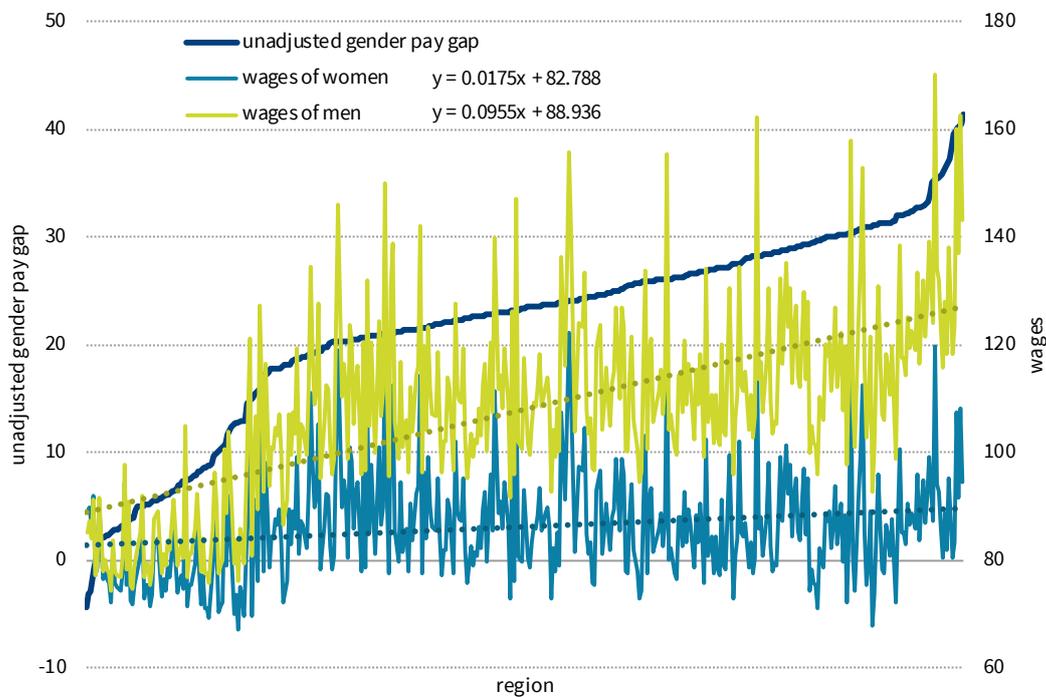
Figure 1: The unadjusted gender pay gap in German regions, 2016



Note: The numbers in brackets denote the number of regions per size group.  
Source: BeH; own calculations.

A quick look at the two regions with the highest and the lowest GPG reveals marked differences, but also similarities between men and women in selected explanatory variables (see Table A 3 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 comparatively high share of low-qualified women in the *Bodenseekreis*, together with the high share of high-qualified men. In addition, unlike in the average region, men in *Cottbus* feature a lower tenure than women. What is more, the economic setting of the two regions provides different job opportunities for both genders. In *Cottbus*, women show a strong focus on public administration jobs, whereas in the *Bodenseekreis* men mostly perform machine building and operating jobs. Unlike *Cottbus*, the *Bodenseekreis* is characterized by a high share of large enterprises that pay high wages and feature a high degree of wage dispersion.

**Figure 2: Relation between wages of women, wages of men and the gender pay gap in the German regions**



Note: The regions are sorted in increasing order of their GPG. The linear trend lines depict the generalized level of the wages of women and men (y) in the sorted regions (x), respectively.

Source: BeH; own calculations.

Figure 2 displays the relation between gendered wages and the GPG for all regions, sorted in increasing order of their GPG. It becomes evident that women’s wages are relatively stable across the regions, whereas men’s wages are clearly higher in regions with a high GPG. Only the regions with a negative and very low GPG deviate slightly in that wages are relatively low for both genders.<sup>13</sup> Still, the slope of the linear trend line across the regions is 0.10 for the wages of men, but

<sup>13</sup> This pattern also holds at the national level: wage gaps are lower in East European countries with lower average wage levels than in West European countries (Boll et al. 2016).

only 0.02 for the wages of women.<sup>14</sup> These results corroborate a generally stronger correlation between the wages of men and the regional GPG as well as a larger impact of men's wages on the GPG. Obviously, the wages of men drive the regional pattern of the GPG much more than the wages of women. In the following section, we will shed more light on these gender-specific determinants.

## 4.2 Decomposition results

In order to answer our research questions, we adopt a two-step approach. First, at the national level we examine the role of regional characteristics for the GPG. To this, we decompose the GPG in Germany as a total and incorporate all individual, establishment and regional characteristics from Table 1 (section 4.2.1). Second, we perform OB-decompositions for each region separately (section 4.2.2). Specifically, we examine which role the factors found to be important at the national level play at the regional level and how their impact differs across regions. Last, we perform complementary decompositions as robustness checks for our main results (section 4.2.3).

### 4.2.1 Decomposition of the national gender pay gap

The decomposition of the national GPG rests on separate wage regressions for women and men in Germany (see equations (1) and (2) in chapter 3.3). The results depicted in Table A 4 in the Appendix display highly significant coefficients and the expected signs for most of the explanatory variables. Two noteworthy findings relate to the employees' age and the establishments they work in. First, for men, the relation between wages and age is generally stronger than for women, and wages also increase with age to a larger degree. Second, although wages increase along with establishment size for both genders, the boost in wages that goes along with working in a high-wage establishment is larger for men. Obviously, possessing labor market experience as well as working in establishments with a high average wage level is more rewarded for men than for women.

Using the regression results for the decomposition in equation (3) yields a national gap in average wages of men and women of 21.4 %. We find that for Germany 6.6 percentage points or about 31 % of the gap represent the explained part and can be traced back to the explanatory factors included in our analysis. 14.8 percentage points remain as the unexplained part.<sup>15</sup> Hence, the largest share of the gap cannot be ascribed to differences in observed employee attributes, but in their valuation as well as to unobserved factors. This is a general result for many countries and not surprising, given the data limitations that are unavoidable when analyzing the GPG (Simón 2012; Boll et al.; 2016; OECD 2017).

Figure 3 documents which share of the explained and unexplained part of the GPG can be attributed towards which group of measured characteristics (detailed results are contained in Table A 5 in the Appendix). It becomes clear that the establishment characteristics play the most important role for the explained part, contributing 4.3 percentage points to the overall GPG. Among these, gender differences in working in a high-wage establishment are the prime factor (3.2 percentage points). In particular, the wage regressions (Table A 4 in the Appendix) assign men who work in establishments with a median daily wage of 500 Euro and more the highest wage effect of

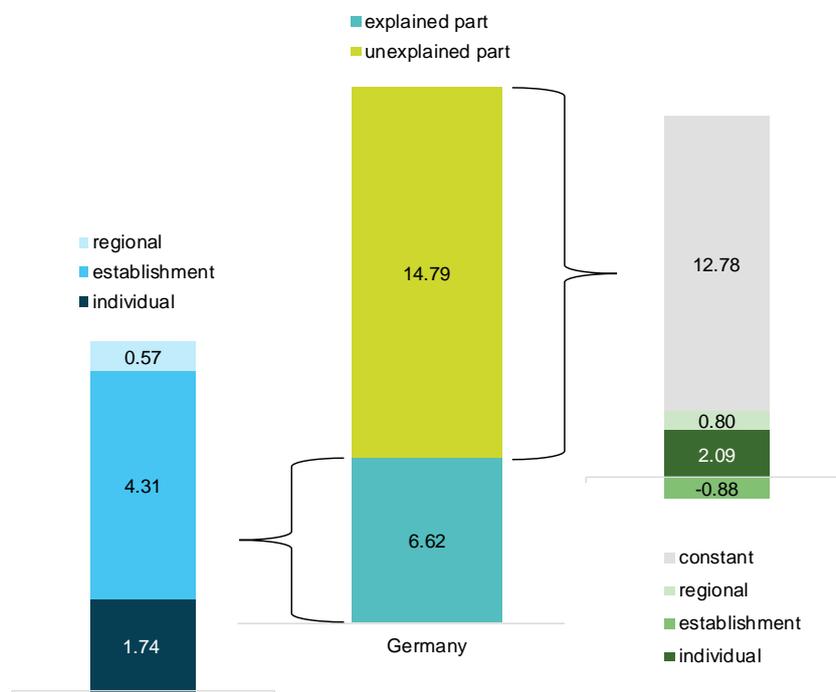
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<sup>14</sup> In the following, the linear trend functions serve as a summarizing presentation method of the regional results, with the advantage that outliers do not bias the central findings.

<sup>15</sup> Similar values for Germany are reported by Gartner/Hinz (2009).

all establishment groups. This observed gender-specific sorting into high- and low-wage establishments is consistent with the findings of Arumpalam/Booth/Bryan (2007), Goldin et al. (2017) and Card/Cardoso/Kline (2016), who conclude that men sort into higher-paying firms and benefit more from pay premiums in these firms. The role of sorting for the GPG is further reinforced by the second important relevant factor, which is the wage dispersion within an establishment. The higher propensity of men to sort into establishments with a high wage dispersion found in the wage regressions raises the GPG by 0.6 percentage points. These results are consistent with the existence of a double burden for women documented by Card/Cardoso/Kline (2016) in that they tend to work at firms that offer smaller wage premiums and additionally tend to earn smaller premiums than their male colleagues working in the same establishment.

**Figure 3: Decomposition results for the national gender pay gap**



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

In comparison to the establishment features, gender differences in individual characteristics explain a smaller part of 1.7 percentage points of the GPG. Here, age enters with a positive value of 0.9 percentage points. The wage regressions show that, especially for men, age is an important factor in the determination of wages. Evidently, age, going along with labor market experience, is rewarded more for men than for women in monetary terms (Manning/Swaffield 2008; Bertrand/Goldin/Katz 2010).<sup>16</sup> Another factor that increases the GPG by 0.5 percentage points is the gender distribution of supervisory positions. Although the wage regressions assign a larger impact for women, their under-representation in top jobs might still give way to a higher GPG in the line of Fortin/Bell/Böhm (2017). Taken together with the results on the establishment features, this

<sup>16</sup> As noted in section 3.2, we do not include an explicit measure of labor market experience due to multicollinearity with age and career interruption. Hence, age also carries other relevant factors like experience that increase with age.

hints towards the existence of a ‘glass ceiling’ in Germany that prevents women of getting into top jobs. Furthermore, the sorting of men and women into different occupations enters negatively in explaining the GPG (see Boll et al. 2016 for similar results). Obviously, the gender-specific selection of occupations mitigates the GPG by 0.4 percentage points in that women tend to cluster in better-paid occupational groups. At first sight, this seems to contradict the theories on occupational segregation as a reason for lower wages of women presented in section 2. However, it might well be the case that our occupational breakdown is still too broad to capture the full extent of gender-specific sorting or does not cover vertical hierarchy in a satisfying way. This is an important aspect, because there are profound gender differences in the sorting into hierarchical positions within occupations (Bettio/Verashchagina 2009).

Among further individual characteristics, the kind of employment contract also matters for unequal wages. The wage regressions show that working in a temporary position reduces wages even more for men than for women, thus confirming the findings of Booth/Francesconi/Frank (2002) and Simón (2012) in that these individuals invest less in job-specific human capital. The larger dispersion of temporary contracts among women contributes to an increase of the GPG of 0.3 percentage points. In contrast, the better endowment of women with formal human capital reduces the GPG. A slightly smaller relevance emerges for gender differences in work experience. Tenure, which denotes the days in employment in the current establishments, contributes to a widening of the GPG by 0.2 percentage points. Basically the same impact goes back to career interruptions that capture child-related labor market absence, *inter alia*. Last, a rather large part of the GPG can also be explained by the diverging patterns of men and women with respect to commuting behavior. Although the wage regressions ascertain men and women basically the same positive impact on wages, the higher propensity of men to commute and the longer commuting distances result in a widening of the GPG by 0.3 percentage points. Evidently, gender differences in interregional mobility for reaching the place of work play a role.

The group of specific regional characteristics constitutes the third group of impact factors. Among the single variables, the largest increase in the GPG of 1.0 percentage points originates from the regional dummies that capture region-specific heterogeneity. Evidently, in each region there are idiosyncratic features that are beyond the variables considered here and that impact gendered wages in different ways. This finding underscores the necessity to conduct decompositions for each region separately, as will be done in the following section. The effect of regional heterogeneity is reduced by specific East German features, however, because working in East Germany reduces the GPG by 0.6 percentage points. For example, these might encompass East-West differences in the self-perception of women on the labor market. Likewise, labor market density reduces the GPG, pointing towards a larger benefit from agglomeration economies for women in the sense of Phimister (2005), Hirsch/König/Möller (2013) or Bacolod (2017). The unemployment rate has an impact of 0.4 percentage points and is responsible for a widening of the GPG. In regions with high unemployment, establishments dispose of a higher bargaining power against workers, which entails lower wages particularly for women (Busch/Holst 2008).

A possible explanation for the relatively low impact of the regional characteristics might be that the regions’ endowment with certain factors is already captured by the individual and establishment characteristics. For example, the occupation variable contains implicit information on the sectoral structure in a region, and the variable on the wage level indicates the availability of well-

paid jobs. Nonetheless, the results underscore the need take into account regional features of the labor market besides the commonly used individual and establishment characteristics.<sup>17</sup>

The unexplained part in Figure 3 constitutes the largest part of the overall GPG. For all three groups of variables it implicitly includes endowment effects resulting from non-included variables especially covering hierarchical and occupational sorting or negotiating skills. The effect of a different evaluation of measured characteristics in the male and female employees is also contained. Furthermore, it includes the constant term that captures the impact of unobserved variables.<sup>18</sup>

#### 4.2.2 Decomposition of the regional gender pay gap

Having quantified the main driving factors on the GPG at the national level, we now proceed to their impact at the regional level. To this, we conduct OB-decompositions for each NUTS 3-region separately. Since the regional characteristics do not vary within regions between women and men, they are consequently excluded here, and we only consider individual and establishment characteristics (see Table 1).

First, we want to find out how much the explained and unexplained part of the GPG differs between the regions and if there is any distinctive pattern. Figure 4 uncovers remarkable differences. The linear trend line of the explained part has a positive slope across the sorted regions, which means 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 observable characteristics included in our model have a greater explanatory power in regions with either a high or a low GPG, explaining up to 66 % of the GPG at each end. This becomes very clear for *Cottbus*, where the explained part amounts to - 12.1 percentage points of the overall GPG of - 4.3%, and for the *Bodenseekreis* with 22.8 percentage points of the overall GPG of 41.4 % (see Table A 5 in the Appendix). In the other regions the explained part accounts to around 30 % of the GPG, thus reflecting the national average. In contrast to the explained part, the unexplained part is positive in all regions and exhibits only slight regional differences. The relatively small slope of the corresponding trend line (0.02) underlines this finding. These first broad results underscore once more the importance to dissect the decomposition of the GPG at the regional level.

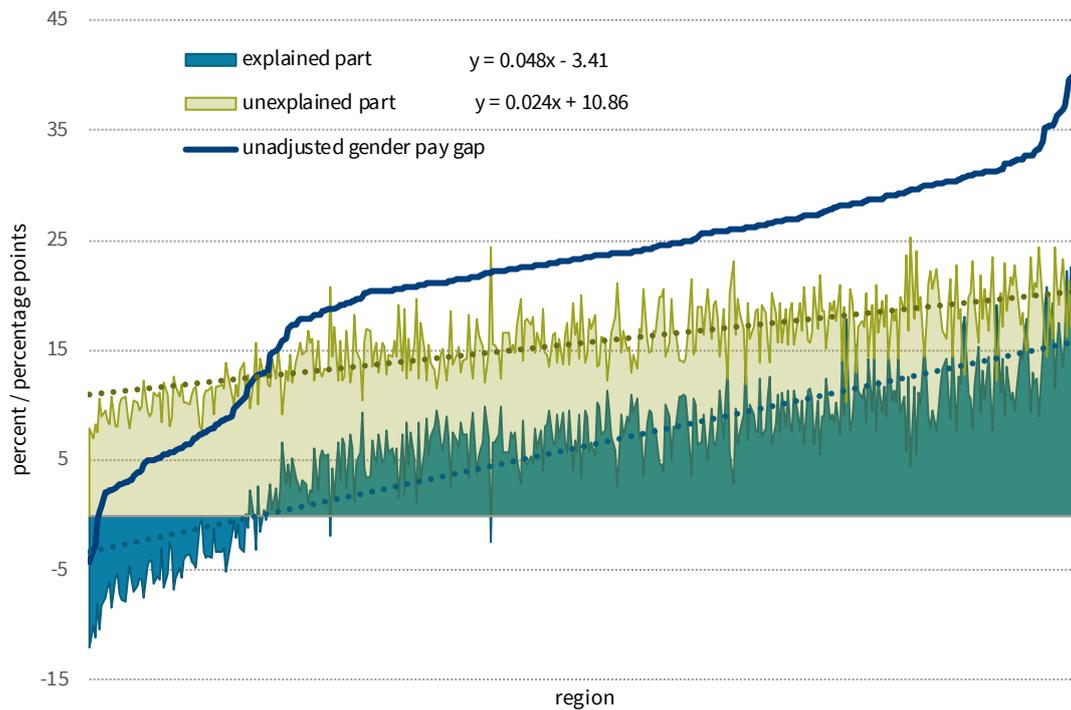
The comparison of Figure 4 with Figure 2 uncovers a strong interrelation between the spatial pattern of women's and men's wages and the explained part of the regional GPG. Putting men's rising wages from the left to the right in Figure 2 goes hand in hand not only with an increasing GPG (which they dominate), but also with an increasing endowments advantage over women as evidenced in Figure 4. Since we know from Figure 2 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 male counterparts in regions with a low GPG. This view complies with a negative explained part of the GPG in 70 regions, indicating that there, women possess better endowments in observed characteristics.

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<sup>17</sup> Conducting the wage regressions and the decomposition without regional variables reduces the explained part to 6.51 %.

<sup>18</sup> One reason for the high value of the constant might be the restriction to full-time employees. Therefore, we will conduct complementary BO-decompositions in section 4.2.3 that also consider part-time employment.

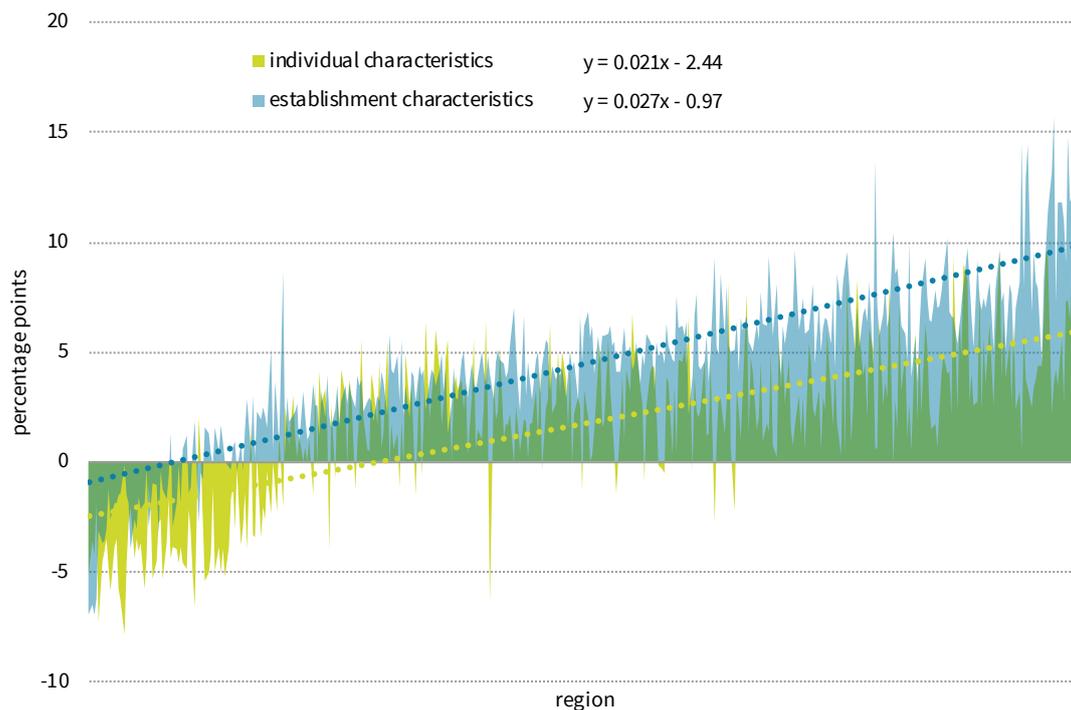
**Figure 4: Explained and unexplained part of the regional gender pay gaps**



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.

Further disentangling the explained part in Figure 5 makes clear that individual and establishment characteristics play different roles across the regions. At the lower end of the regions, women have better observed endowments in both individual and establishment characteristics, whereas the opposite is true at the upper end. In 45 regions, both individual and establishment characteristics reduce the GPG, while in 52 regions only the individual features are negative. The larger impact of establishment factors can also be inferred from the slope of the two trend lines, which increases more along the regional GPG distribution than that of the individual factors (0.03 vs. 0.02). In the majority of the regions, however, both groups of factors point towards better observed endowments of men in terms of wages.

**Figure 5: Decomposition of the explained part of the regional gender pay gaps**



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.

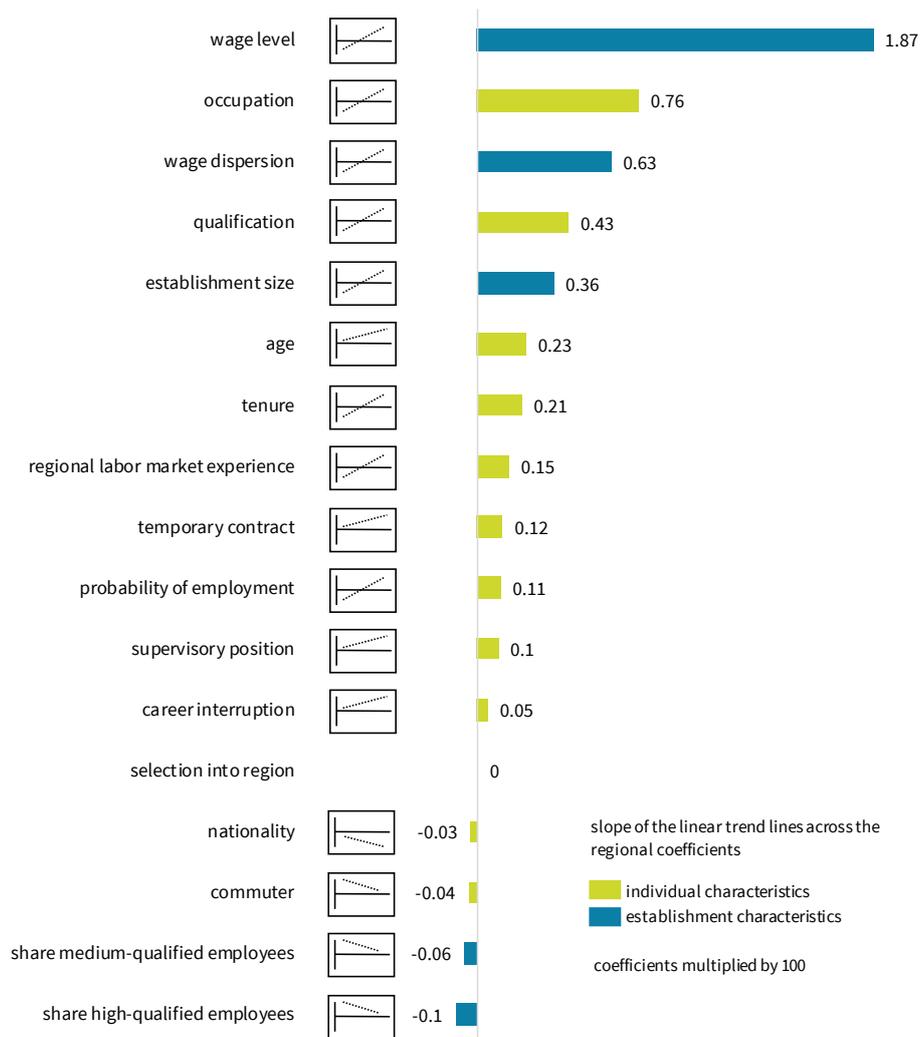
Sources: BeH, IEB, BHP; own calculations.

Going one more step into detail, Figure 6 displays the results of the explained part for each individual and establishment characteristic separately. For reasons of clarity, we present only the linear trends that summarize the sign and the magnitude of the respective variable from the decomposition results for each region (see Table A 5 in the Appendix for detailed decomposition results for the two extreme regions). Besides the slopes of the linear trends, we depict their stylized position with respect to the horizontal axis. The slope of the linear trend line answers the question how large the regional differences are in the respective variable. The larger the slope, the more the regions differ. The stylized position of the trend line with respect to the horizontal axis answers the question whether the impact of the variable changes in its direction 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 6 clearly state that the explanatory characteristics have a very different impact on the GPG in the single regions. This is especially the case for those variables that are derived from theories of segmented labor markets, as can be deduced from the high slope of the trend lines. The largest differences with respect to the regional impact on the GPG can be ascribed to the wage level within the establishment. Here, the slope amounts to 1.87. The corresponding stylized diagram documents a negative impact in regions with a low GPG that translates

into a positive impact in regions with a medium and high GPG.<sup>19</sup> The latter result corresponds with the findings on the national level and of other studies in that men sort into well-paid jobs within establishments (Card/Cardoso/Kline 2016; Barth/Kerr/Olivetti 2017; Hara 2018). However, 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.

**Figure 6: Detailed results for the explained part of the regional gender pay gaps**



Note: The stylized diagrams depict the position and the slope of the linear trend lines of the respective variables across the sorted regions.

Sources: BeH, IEB, BHP; own calculations.

The second characteristic that shapes regional disparities in the GPG is gender-specific occupation. Just like for the wage level, its impact is negative in regions with a negative and low GPG and increases along with the GPG. 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

<sup>19</sup> This is clearly the case in the two regions with the lowest and the highest GPG. In *Cottbus* the wage level variable reduces the GPG by 5.6 percentage points, whereas in the *Bodenseekreis* it enhances the GPG by 6.1 percentage points (see Table A 5 in the Appendix).

well-paid occupations. Again, *Cottbus* and the *Bodenseekreis* serve as good examples (see section 4.1 and Table A 3 in the Appendix). This diverging impact on the level of the regions breaks up the slight negative impact of occupation on the national level, confirming the theories of occupational segregation at least for regions with a medium or high GPG. Furthermore, since occupation is strongly correlated with the sectoral composition of a region, its strong impact on the regional GPG hints towards an equally strong impact of the regional economic structure.

Wage dispersion and establishment size are two further characteristics based on the theory of segmented labor markets and also of high relevance not only in explaining gender wage differences in general, but also differences in the regional GPGs. Their impact is negative in regions with a low overall GPG and then turns positive in regions with a high GPG. Since many regions with a negative and low GPG are located in East Germany, one straightforward explanation might be provided by the smaller-scale establishment size structure in the Eastern part of the country (Müller et al. 2018), going along with a lower level of wage dispersion.

Turning towards the characteristics that are rooted in human capital theory, qualification turns out to be the most important determinant. Again, gender differences in qualification mitigate the GPG in regions on the left-hand side of the regional GPG distribution and increase it in regions at the right-hand side. This might reflect the generally higher level of formal qualification of East German women in particular that lead to higher wages (see Table A 3 and Table A 5 in the Appendix). 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 on the GPG along the whole regional GPG distribution, thus mirroring the results on the national level. The same holds for holding a temporary contract and a supervisory position. Overall, we can conclude that mainly in regions with a high GPG the impact of the factors representing human capital theory coincides with theoretical reasoning. This also holds for variables that are derived from segmented labor markets approaches.

In contrast to the explained part, the BO-decomposition results of the unexplained part do not show any pattern along the regional GPG distribution. Furthermore, the valuation of individual and establishment characteristics does not seem to vary systematically across regions. This might be explained with the high relevance of the regional fixed effects in the decomposition of the national GPG. They capture the contribution of idiosyncratic features inherent in each region in such a way that only white noise remains in the unexplained part.

Summing up the decomposition results for the regional GPG, with regard to the explained part half of our included variables change their impact along the regional GPG distribution. This finding has important implications for the relevance of the theoretical approaches in regional respect, because the empirical evidence collected at the national level is only discernible in a specific subset of regions. Evidently, the very different composition of the German regions plays a decisive role in this respect. In low-GPG regions, larger establishments with high-paid jobs in the manufacturing sector for men are absent, as is striking in the descriptive statistics and in the decomposition of the GPG in the two regions with the lowest and the highest GPG (see Table A 3 and Table A 5 in the Appendix). In addition, in these regions women dispose of individual advantages in qualification or occupation that pay off in higher wages.

### 4.2.3 Robustness checks

In order to control and to complement our main results, we run supplementary decompositions referring to four different aspects. Foremost, although we use a comprehensive dataset, we nevertheless encounter some data restrictions. We therefore start with the shortcoming that the wages in our data are right-censored. As described in section 3.1, wages above the social security contribution ceiling do not have to be reported, which we accounted for in the main results by using imputed wages. We now run the decompositions without the respective employees. As expected, the GPG for Germany is lower than in the main results as we exclude extremely high wages (see Table 2). However, the explained part makes up only 2.6 percentage points of the overall 14.7 %, thus explaining only 17 % of the unadjusted GPG as opposed to 31 % in the main results. Among the three groups of explanatory characteristics, establishment factors still have the largest impact, but they are now followed by regional features. Concerning the decomposition results for the regions, there are minor changes in the regional ranking. However, the patterns regarding the explained and unexplained part as well as the contribution of the individual and establishment characteristics (Figure 4 and Figure 5) remain largely unaffected.

**Table 2: Complementary decomposition results for the national gender pay gap**

	GPG	Explained part	Unexplained part
<b>Main results: only full-time employees</b>	<b>21.41</b>	<b>6.62</b>	<b>14.79</b>
Without imputed wages	14.65	2.62	12.03
Full-time plus part-time employees	12.00	-3.62	15.62
Only part-time employees	2.87	-7.11	9.98
Manufacturing	28.84	6.76	22.08
Public sector	8.50	2.66	5.84
Only stayers in the region	26.82	11.75	15.07

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

Second, since we have no information on the exact working time in our data, we concentrated our main analysis on full-time workers, as also proposed in the literature (e. g., Kunze 2005; Blau/Kahn 2017). Because part-time work is known to be an important driving factor of the GPG (see also section 2), we nevertheless include part-time employees in two further supplementary decompositions. To this, we need to impose assumptions on the actual number of hours worked in order to calculate hourly wages. We draw our assumptions from the Federal Statistical Office in Germany (Rengers/Bringmann/Holst 2017).<sup>20</sup> The GPG is considerably lower if we include part-time workers, which can be traced back to the small hourly wage differences between men and women who work part-time.<sup>21</sup> Furthermore, the explained part becomes negative. This can be ascribed to the large impact of full-time work, which reduces wage difference between men and women by 12.8 percentage points. When we only consider part-time employees, the GPG is even more reduced. These

<sup>20</sup> In Germany, male full-time employees work 8.2 hours per day and female full-time employees 7.92 hours per day, whereas male part-time employees have a working time of 3.74 hours per day and female part-time employees of 4 hours per day.

<sup>21</sup> Part-time employed women in our data earn 53.46 Euro per day and men 55.01 Euro.

findings corroborate the key role of working time arrangements for the lower wages of women (Manning/Petrongolo 2008). In regional respect, the number of regions with a negative GPG increases, leading to slight changes in the regional ranking. For full-time employed only, the explained part of the GPG increases in relevance in regions with a low GPG, which includes a mitigating impact of establishment characteristics for almost all regions.

The third aspect considers any sectoral peculiarities that do not emerge in the decomposition for all sectors. In section 4.2.2, we highlighted the respective composition of the regions with establishments and jobs as major determinants for the differences in the regional GPG. We therefore only consider full-time workers in the manufacturing sector that rather provides well-paid jobs for men and the public sector that is dominated by female employees (Olivetti/Petrongolo 2016; OECD 2017). The two sectors underlie different wage-setting processes. Whereas in manufacturing, wages are more often determined by market mechanisms and individual bargaining contracts, the wage setting process in the public sector is rather regulated. Hence, we expect the GPG in manufacturing to be higher than both in the public sector and in the main results, which we also find in Table 2. The GPG in manufacturing is even more than three times as high as in the public sector, which is in line with findings of Boll/Lagemann (2018). In both sectors, the explained part is positive, which means that the GPG increases through gender differences in observable characteristics. Compared to individual features, the establishment features play a significantly more important role in manufacturing and a slightly more important role in the public sector, corroborating our conclusions that the economic structure of a region plays a crucial role in explaining the differences in the GPG across the regions. The regional decompositions bring along major changes in the ranking of the regions. For manufacturing only, the unexplained part of the GPG is very high in almost all regions, and gender differences in establishment characteristics play everywhere a more prominent role than in the main results. In the public sector, in contrast, the explained part turns out to be higher in regions with a low GPG, and gender differences in individual characteristics take the lead in explaining the GPG.

The fourth aspect addresses the regional mobility of employees and their possible selection into the region related to the current job. To check for any resulting spatial biases, we exclude employees who worked in another region prior to their current employment. The decomposition attests the stayers in the region a higher GPG than in the main results. The explained part is higher, explaining 44 % of the unadjusted GPG. Again, gender differences in establishment features are the prominent explanation, followed by individual features. This result hints towards the role of regional mobility for obtaining higher wages especially for women. The regional decompositions bring along only minor deviations from the main results.

## 5 Conclusions

Based on detailed information on all full-time employees in Germany, this paper provides first-time evidence on the magnitude and determinants of regional differences in the GPG. We apply Oaxaca-Blinder decompositions for Germany and its 401 NUTS3-regions in order to explain the regional variation of the GPG with individual, job-related and regional characteristics. On average,

women earn 21 % less than men at the national level. However, on the regional level, we find profound differences. Most notably, the GPG is very low in East Germany, amounting to 6.2 % as compared to 23.4 % in the Western part of the country. Overall, the regional GPG varies between -4.3 % in *Cottbus* (East Germany) and 41.4 % in the *Bodenseekreis* (West Germany).

The decomposition of the national GPG shows that establishment characteristics play a crucial role in explaining the wage differences between men and women. Most importantly, men sort into higher-paying firms and benefit more than women from pay premiums in these firms. In contrast, individual and regional characteristics exert a rather small impact. Here, the sorting of women and men into different jobs is an important factor, since women are overrepresented in occupations with low pay levels.

Although specific regional characteristics only play a minor role in explaining the GPG at the national level, the large variation of the GPG across regions underscores the necessity to conduct decompositions at the regional level. Separate decompositions for each region provide novel findings on the very different roles of the observed individual and establishment characteristics in regional respect. Generally, the explained part of the GPG is very high in regions with either a low or a high GPG. However, gender differences in individual features are more important in regions with a low or negative GPG, whereas establishment factors play a prominent role in regions with a high GPG. These results assign the underlying theoretical approaches a distinctly regional component that differs between specific subsets of regions.

The decomposition results reflect the profound regional disparities in Germany concerning both the labor market and the economic composition. Men's wages drive the regional variation in the GPG much more than women's wages. Consequently, the results specifically highlight the availability of highly-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 addition, the endowment of male and female employees with individual human capital factors such as qualification, age, and work experience considerably varies 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 Western Germany.

Our results emphasize that policy measures aimed at reducing the GPG in general terms should definitely take the regional economic structure and the spatially uneven distribution of employment opportunities of men and women into account. First of all, women should be better informed about the job and earnings opportunities they have in their region. This is especially relevant in regions with a high GPG. Measures to increase spatial mobility could also be helpful since the lower mobility of women is one reason why they do not profit as much as men do from job opportunities in nearby regions. In particular women in rural regions are confronted with mobility issues. Support could be provided by the further expansion of full-time child care in day-care facilities and primary schools, especially in the West German regions. This is further necessary in order to give both men and women the opportunity to better reconcile family-related career breaks with personal work preferences. Another more general approach to reduce the GPG could be the provision of more professional training opportunities especially for women working part-time. Although professional training is the basis for career development, women less frequently participate in fur-

ther training. Apart from concrete measures, changes in moral values and social roles that are necessary to reduce the GPG in national, but also in regional respect should be more strongly supported by politicians, the society and local employers.

The results on the magnitude and determinants of the regional GPG presented in this paper clearly face some restrictions that should be approached in future work. Foremost, an extension originates from the fact that wage differences between men and women vary along the overall wage distribution. Therefore, decomposition methods based on quantile regressions should be applied as a next step. Furthermore, it would be very informative to conduct regional decompositions of the GPG for other countries in order to bring to light whether the impact of the various theoretical approaches also differs systematically in regional respect.

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# Appendix

**Table A 1: Definition of the explanatory variables**

Variable name	Definition
<b>Individual characteristics</b>	
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 (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 2016, 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 (June 30, 1996 to June 30, 2016) (%)
<b>Establishment characteristics</b>	
Establishment size	Dummy 1: <11 employees, 2: 11-20 employees, 3: 21-50 employees, 4: 51-250 employees, 5: >250 employees
Share medium-qualified employees	Share of medium-qualified employees on all employees (%)
Share high-qualified employees	Share of high-qualified employees 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 median in €
<b>Regional characteristics</b>	
Labor market density	Share of employees on all inhabitants per region (%)
Establishment size structure	Share of employees in establishments with more than 250 employees (%)
Unemployment rate	Unemployment rate in 2016 (%)
Religion	Share of inhabitants with Roman Catholic denomination on all inhabitants per region (%)
East Germany	Dummy 1: yes, 0: no
Regional fixed effects	Dummy for each region

Source: own compilation.

**Table A 2: Descriptive statistics for the explanatory variables, Germany**

Variable	Number of observations	Mean	Minimum	Maximum
<b>Individual characteristics</b>				
Age: 15-19 years	17,861,493	0.00	0	1
Age: 20-24 years	17,861,493	0.05	0	1
Age: 25-29 years	17,861,493	0.11	0	1
Age: 30-34 years	17,861,493	0.12	0	1
Age: 35-39 years	17,861,493	0.11	0	1
Age: 40-44 years	17,861,493	0.11	0	1
Age: 45-49 years	17,861,493	0.14	0	1
Age: 50-54 years	17,861,493	0.16	0	1
Age: 55-59 years	17,861,493	0.13	0	1
Age: 60-64 years	17,861,493	0.07	0	1
Qualification: low	17,861,493	0.05	0	1
Qualification: medium	17,861,493	0.74	0	1
Qualification: high	17,861,493	0.21	0	1
Tenure	17,861,493	2,510.26	1	6,210
Career interruption	17,861,493	6.32	0	97.36
Temporary contract	17,861,493	0.12	0	1
Occupation <sup>1)</sup>	17,861,493		0	1
Supervisory position	17,861,493	0.04	0	1
Nationality	17,861,493	0.07	0	1
Commuter	17,861,493	0.43	0	1
Selection into region	17,861,493	0.14	0	1
Regional labor market experience	17,861,493	52.36	0	99.98
<b>Establishment characteristics</b>				
Establishment size: <11 empl.	17,861,493	0.12	0	1
Establishment size: 11-20 empl.	17,861,493	0.09	0	1
Establishment size: 21-50 empl.	17,861,493	0.15	0	1
Establishment size: 51-250 empl.	17,861,493	0.30	0	1
Establishment size: >250 empl.	17,861,493	0.35	0	1
Share medium-qualified employees	17,861,493	68.47	0	100
Share high-qualified employees	17,861,493	19.22	0	100
Wage level: <50 €	17,861,493	0.03	0	1
Wage level: 50-99 €	17,861,493	0.41	0	1
Wage level: 100-199 €	17,861,493	0.52	0	1
Wage level: 200-499 €	17,861,493	0.04	0	1
Wage level: >499 €	17,861,493	0.00	0	1
Wage dispersion	17,861,493	23.89	0	280.46
<b>Regional characteristics</b>				
Labor market density	401	418.16	153.20	1,028.20
Establishment size structure	401	13.13	6.73	40.23
Unemployment rate	401	6.91	1.50	16.20
Religion	401	29.85	1.70	87.80
East Germany	401	14.93	0	1

<sup>1)</sup> Occupation comprises 144 dummies for the 3-digit occupations in the *KldB 2010*.

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

**Table A 3: Selected characteristics for Germany and the regions with the lowest and highest gender pay gap**

	Germany	Cottbus	Bodenseekreis
Daily wages (€): men	114.22	85.25	143.05
women	92.21	88.96	94.52
Average age: men	44	45	43
women	42	46	42
Share low-qualified emp. (%): men	4.9	1.5	8.1
women	4.8	1.0	10.4
Share high-qualified emp. (%): men	20.5	22.2	29.5
women	21.8	27.5	20.8
Tenure (days): men	2,571	2,391	2,866
women	2,381	2,930	2,294
Share of commuters (%): men	45.3	51.2	29.6
women	38.2	45.8	23.1
Share of establishments with more than 250 employees (%)	34.9	26.3	45.3
Top 3 occupations: men (%)	<ol style="list-style-type: none"> <li>1. Occupations in machine-building and -operating (7.3)</li> <li>2. Occupations in warehousing and logistics, in postal and other delivery services, and in cargo handling (6.1)</li> <li>3. Occupations in business organisation and strategy (5.4)</li> </ol>	<ol style="list-style-type: none"> <li>1. Driver of vehicles in road traffic (6.7)</li> <li>2. Occupations in machine-building and -operating (5.5)</li> <li>3. Occupations in business organisation and strategy (4.9)</li> </ol>	<ol style="list-style-type: none"> <li>1. Occupations in machine-building and -operating (14.0)</li> <li>2. Occupations in metalworking (6.7)</li> <li>3. Occupations in business organisation and strategy (5.9)</li> </ol>
Top 3 occupations: women (%)	<ol style="list-style-type: none"> <li>1. Office clerks and secretaries (12.1)</li> <li>2. Occupations in business organisation and strategy (7.3)</li> <li>3. Occupations in education and social work, and pedagogic specialists in social care work (5.8)</li> </ol>	<ol style="list-style-type: none"> <li>1. Occupations in public administration (13.7)</li> <li>2. Office clerks and secretaries (9.9)</li> <li>3. Occupations in business organisation and strategy (8.3)</li> </ol>	<ol style="list-style-type: none"> <li>1. Office clerks and secretaries (11.1)</li> <li>2. Occupations in education and social work, and pedagogic specialists in social care work (6.2)</li> <li>3. Occupations in business organisation and strategy (5.0)</li> </ol>
Share of employees in establishments with a median wage below 100 € (%)	43.6	56.3	28.2
Wage dispersion (€)	23.9	16.6	31.3

Sources: BeH, IEB, BHP; own calculations.

**Table A 4: Results of the wage regressions for women and men, Germany**

	Women			Men		
<b>Individual characteristics</b>						
Age: 15-19 years	Reference			Reference		
20-24 years	0.117	(0.004)	***	0.148	(0.004)	***
25-29 years	0.166	(0.005)	***	0.229	(0.004)	***
30-34 years	0.198	(0.005)	***	0.289	(0.004)	***
35-39 years	0.204	(0.005)	***	0.323	(0.004)	***
40-44 years	0.218	(0.005)	***	0.342	(0.004)	***
45-49 years	0.228	(0.005)	***	0.355	(0.004)	***
50-54 years	0.221	(0.005)	***	0.351	(0.004)	***
55-59 years	0.207	(0.005)	***	0.335	(0.004)	***
60-64 years	0.186	(0.005)	***	0.312	(0.004)	***
Qualification: low	Reference			Reference		
medium	0.035	(0.001)	***	0.050	(0.000)	***
high	0.192	(0.001)	***	0.257	(0.001)	***
Tenure	0.000	(0.000)	***	0.000	(0.000)	***
Career interruption	-0.002	(0.000)	***	-0.001	(0.000)	***
Temporary contract	-0.066	(0.000)	***	-0.092	(0.000)	***
Occupation	Included			Included		
Supervisory position	0.303	(0.001)	***	0.283	(0.000)	***
Selection into employment	-0.060	(0.004)	***	-0.004	(0.003)	***
Nationality	-0.042	(0.001)	***	-0.057	(0.000)	***
Commuter	0.035	(0.000)	***	0.038	(0.000)	***
Selection into region	0.022	(0.000)	***	0.008	(0.000)	***
Regional labor market experience	0.001	(0.000)	***	0.001	(0.000)	***
<b>Establishment characteristics</b>						
Establishment size: <11 employees	Reference			Reference		
11-20 employees	0.056	(0.001)	***	0.033	(0.000)	***
21-50 employees	0.082	(0.001)	***	0.044	(0.000)	***
51-250 employees	0.112	(0.000)	***	0.059	(0.000)	***
> 250 employees	0.160	(0.001)	***	0.107	(0.000)	***
Share medium qualified employees	0.000	(0.000)	***	0.001	(0.000)	***
Share high qualified employees	0.000	(0.000)	***	0.000	(0.000)	***
Wage level: <50 €	Reference			Reference		
50-99 €	0.438	(0.001)	***	0.448	(0.001)	***
100-199 €	0.741	(0.001)	***	0.708	(0.001)	***
200-499 €	1.012	(0.001)	***	0.901	(0.001)	***
>499 €	0.371	(0.020)	***	0.935	(0.006)	***
Wage dispersion	0.002	(0.000)	***	0.006	(0.000)	***
<b>Regional characteristics</b>						
Labor market density	0.000	(0.000)	***	0.000	(0.000)	***
Establishment size structure	-0.001	(0.000)	***	-0.006	(0.000)	***
Unemployment rate	-0.007	(0.000)	***	-0.012	(0.000)	***
Religion	0.000	(0.000)	***	0.000	(0.000)	***
East Germany	-0.054	(2.016)	***	0.247	(0.000)	***
Regional fixed effects	Included			Included		
<b>Constant</b>	3.262	(0.000)	***	3.313	(0.000)	***
Number of observations	5,743,472			12,118,021		
R <sup>2</sup>	0.591			0.698		

Note: OLS regressions. Robust standard errors reported in parentheses. Dummies for the regions included. \*/\*\*/\*\* indicates statistical significance at the 10/5/1% level, respectively.

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

**Table A 5: Detailed decomposition results for the explained part of the gender pay gap for Germany and the regions with the lowest and highest gender pay gap**

	Germany	Cottbus	Bodenseekreis
<b>Overall GPG</b>	<b>21.41</b>	<b>-4.26</b>	<b>41.43</b>
<b>Explained GPG</b>	<b>6.62</b>	<b>-12.08</b>	<b>22.79</b>
<b>Individual characteristics</b>	<b>1.74</b>	<b>-5.13</b>	<b>10.68</b>
Age	0.92	0.00	1.44
Qualification	-0.26	-0.84	1.96
Tenure	0.23	-0.77	1.17
Career interruption	0.21	-0.06	0.17
Temporary contract	0.34	-0.08	0.95
Occupation	-0.38	-2.92	3.89
Supervisory position	0.45	0.01	.48
Nationality	-0.10	-0.05	-0.09
Commuter	0.27	0.11	0.09
Selection into region	0.01	0.07	.06
Regional labor market experience	0.04	-0.66	.54
<b>Establishment characteristics</b>	<b>4.31</b>	<b>-6.96</b>	<b>12.12</b>
Establishment size	0.36	0.54	2.15
Share medium-qualified employees	0.18	-0.30	-0.20
Share high-qualified employees	0.05	.11	0.56
Wage level	3.15	-5.64	6.08
Wage dispersion	0.57	-2.67	3.52
<b>Regional characteristics</b>	<b>0.57</b>		
Labor market density	-0.24		
Establish. size structure	0.02		
Unemployment rate	0.38		
Religion	0.04		
East Germany	-0.61		
Regional fixed effects	0.97		
<b>Unexplained GPG</b>	<b>14.79</b>	<b>7.82</b>	<b>18.64</b>

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

# Imprint

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