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Decomposing the German East-West wage gap

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Abstract

We demonstrate that almost one half of the observed wage gap between East and West Germany reflects differences in worker, establishment, and regional characteristics rather than differences in productivity at the establishment level. Regional price and establishment size differentials alone account for one quarter of the overall East-West wage gap. Differences in employees' characteristics and in productivity deliver much smaller but still statistically significant contributions. We derive these results from an Oaxaca-Blinder decomposition using unusually rich linked employer-employee data. Our findings are quite stable over the period from 1996 to 2010 and over the wage distribution.

JEL Code: J31, P25, R11.
Keywords: Wage gap, decomposition, German reunification.

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1. Introduction

In 2015, Germany provides 25 years of experience with economic transition and economic integration, against the background of a common market and common institutions. Studying the particular case of Germany may thus provide a leading example for transition outcomes to be expected somewhere else, for instance with regard to the economic integration in the European Union. We focus on the wage differential between East and West Germany and find that almost half of the observed wage gap is due to differences in worker, establishment, and regional characteristics, most importantly local price levels and the establishment size. In contrast, establishment-level labor productivity (defined as revenue per worker) plays only a minor role in the East-West wage gap. Given that these differences are quite stable over time, we do not expect average nominal wages in Germany to converge considerably in the years to come. However, our findings also imply that convergence measured using aggregate data underestimates true convergence at the individual level. In general, this implies that structural differences should be taken into account properly when assessing cross-country or within-country convergence levels of income or productivity.

East Germany and West Germany reunited in 1990. After 40 years of socialist economy, labor productivity and wages in East Germany lagged far behind the levels of the West German market economy. Labor productivity was one third and wages were less than half of the West German level (see, e. g., Franz and Steiner, 2000). During the transition period in the early 1990s, productivity and wages caught up rapidly toward West German levels, but they have not converged further since then (Aumann and Scheufele, 2010; Barrell and Velde, 2000; Franz and Steiner, 2000; Smolny, 2009; Steiner and Wagner, 1997). In 2014, average hourly productivity in East Germany (as measured by GDP per hour per employee) still fell short of West Germany's productivity by 24% while the gap in gross wages and salaries per hour per worker amounted to 22% (see VGRdL, 2015a,b).

We explore in detail which factors beyond aggregate productivity contribute to the persistent East-West wage gap. We therefore decompose the German East-West wage gap into factors related to worker, establishment, and regional characteristics. To the best of our knowledge, we are the first who explicitly combine these three sources of wage variation in the context of the German East-West wage gap. Our focus is on structural differences rather than on differences in returns. Some structural differences have already been identified, for instance with regard to firm-evel efficiency (Funke and Rahn, 2002), industry structure, and establishment size (Görzig *et al.*, 2005), and locational conditions (Kirbach and Smolny, 2011). Differences in returns may explain why wages earned by East Germans and West Germans in West Germany are about the same while wages earned in East Germany and West Germany still differ significantly (see Gernandt and Pfeiffer, 2008, for a comprehensive analysis).

We focus on five determinants of productivity-independent wage variation that have already received a lot of attention in the literature on wage differentials: female labor force participation rates, union coverage rates, industry structure, establishment size, and agglomeration patterns. Consider, for instance, the gender wage differential: It is well established that women earn less than comparable men in comparable jobs (see, e. g., Nopo *et al.*, 2011; Weichselbaumer and Winter-Ebmer, 2005), although, by construction, there are no productivity differences between them. It is also well established that the female labor force participation rate is higher in East Germany than in West Germany (Matysiak and Steinmetz, 2008; Rosenfeld *et al.*, 2004). Both factors combined imply that the average wage in East Germany is below the average wage in West Germany even if there were no productivity differences between the two regions. A similar argumentation applies to the other four characteristics.

Furthermore, we consider local price levels. German wage data do not acknowledge that costs of living vary considerably between districts. However, workers faced with lower price levels will have lower nominal reservation wages and thus earn lower nominal wages. Their real wage might nevertheless be the same as in a high price area. In East

Germany, local price levels are, on average, lower than in West Germany. The observed differential in nominal wages thus may reflect the differential in local price levels.

In order to estimate the contributions of the six factors to the East-West wage gap, we apply an Oaxaca-Blinder decomposition approach (Oaxaca, 1973; Blinder, 1973) to individual wage data from an unusually large and comprehensive linked employer-employee data set, the LIAB QM2 1993-2010. Our focus is on the post-transition period from 1996 to 2010, when the wage gap itself was relatively stable. We use parameter estimates from unconditional quantile regressions, or RIF-regressions, (Firpo *et al.*, 2007, 2009, 2011) which allow us to decompose the East-West wage gap in detail at different quantiles of the wage distribution.

We investigate how the contributions of the different factors in explaining the observed wage gap evolve over time and how they vary over the wage distribution. Changes over time may arise from long-run labor market trends, for instance the declining union coverage; from labor market reforms, for instance the Hartz reforms implemented in 2003 to 2005; or from business cycle fluctuations. Variations over the wage distribution are likely for characteristics that affect in particular low or high wages. For instance, the effect of union coverage on the East-West wage gap may vary over the wage distribution, as collective agreements usually play a larger role for wages in the lower part of the wage distribution.

For our sample and the whole period between 1996 and 2010, we estimate an East-West wage gap at the median of about 31 Euro per day on average; that is one third of the West German median wage. The wage gap slightly declined until the early 2000s and then started to increase again (see also Brück and Peters, 2009).

Most of the observed East-West wage gap can be explained by differences in local price levels and in employers' characteristics. About 14% of the median wage gap arise because the average price level is lower in East Germany. Another 11% of the median wage gap are accounted for by differences in establishment size, with the average East

German establishment being smaller than the average West German establishment. About 6% of the wage gap can be contributed to the higher share of female workers in East Germany. On average about 4% of the wage gap is due to a relative specialization of the East German economy in rather low-pay industries, and another 2% is on average due to a lower union coverage. Differences in establishment-level labor productivity explain only 2% to 6% of the East-West wage gap. All structural differences together explain almost half of the observed wage gap. The other half can be attributed to differences in returns to the various characteristics.

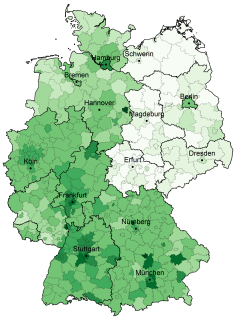
Most of these figures are rather stable over time. However, the share of the wage gap explained by differences in industry structures varies over the business cycle while the share due to union coverage tends to increase over time, as union coverage in East Germany declines relatively to the union coverage in West Germany. The figures are also fairly stable over the wage distribution, albeit some expected differences emerge. Over the wage distribution, the contribution of differences in union coverage to the East-West wage gap declines, while the contributions of differences in local price levels as well as in skills and experience increase. The contribution of differences in female labor force participation follows a u-shaped pattern, being larger toward both ends of the wage distribution than at the median. Our results imply that the East-West wage gap largely reflects structural differences rather than differences in establishment-level labor productivity. Hence, it is rather unlikely that wages will converge considerably in the years to come.

The rest of the paper is organized as follows: Section 2 discusses factors beyond aggregate productivity that potentially affect the East-West wage gap and that are at the core of an extensive theoretical and empirical literature on wage differentials. Section 3 outlines our empirical strategy. Section 4 describes the data set. Results are presented in section 5. Section 6 concludes.

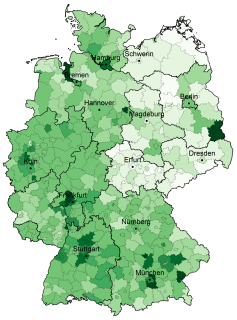
2. Factors that contribute to the East-West wage gap

In terms of average wages and aggregate productivity, East Germany still lags considerably behind West Germany. Figure 1 shows for the year 2010 the regional distribution at the district level of wages, productivity, and potential other sources of wage variation. Light colors refer to low, dark colors to high values. Each variable is measured relative to the German average.

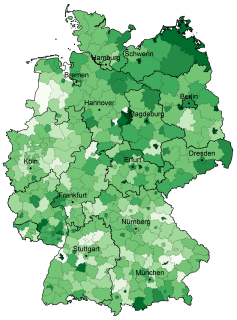
Figure 1: Average wages, aggregate productivity, and potential other sources of wage variation in Germany at the district level, 2010



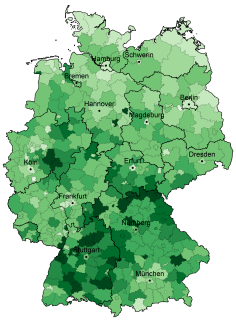
(a) Wages



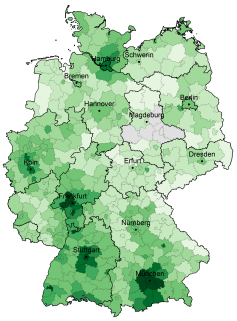
(b) Productivity



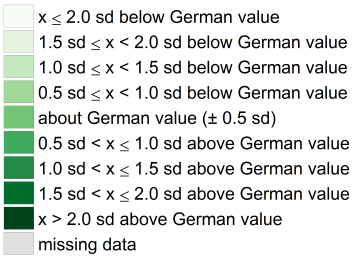
(c) Share of female employees



(d) Share of employees in the manufacturing sector



(e) Local price index



Source: Geodata: © GeoBasis-DE / BKG 2014. Wages (gross wages and salaries per hour per worker): VGRdL (2014a). Productivity (GDP per hour per employee), and manufacturing share: VGRdL (2014b). Share of female employees: BBSR (2015). Local price index: BBSR (2009).

The distribution of average gross hourly wages and salaries reflects the former division of Germany impressively well (see Figure 2(a)). Except for the city of Berlin, wages in all East German districts are still at least one standard deviation lower than the German average. A similar pattern is observed for aggregate hourly labor productivity (see Figure 2(b)).

The observed East-West gap in terms of average wages and aggregate productivity very likely reflects not only productivity differences in the narrow sense, i. e., a less fortunate input-output relation in East Germany, but also differences in structural characteristics. We focus on five determinants of productivity-independent wage variation that have received a lot of attention in theoretical and applied work on wage differentials: the share of female employees, union coverage rates, industry structure, establishment size, and agglomeration patterns. Each of these factors give rise to a wage gap on their own. In our empirical work we additionally inspect the effect of differences in local price levels. In this section, we discuss to what extent each of these six factors may contribute to the observed East-West wage gap.

Gender wage differential

Women often earn less than men. This is a matter of fact all over the world, even when controlling for further worker and establishment characteristics (see, e. g., Al-Farhan, 2010; Nopo *et al.*, 2011; Ludsteck, 2014; Weichselbaumer and Winter-Ebmer, 2005). Hence, all else equal, average wages will be lower in regions where the share of female employees is higher. In Germany, female labor force participation rates have increased since reunification, but have remained lower in West Germany than in East Germany (Matysiak and Steinmetz, 2008; Rosenfeld *et al.*, 2004). The same holds true for the share of female employees, which differed by about five percentage points each year between 1996 and 2010 (see also Figure 2(c)). Hence, the East-West wage gap might partly reflect the gender wage gap. We expect the gender wage gap to provide a considerable and stable contribution to the overall East-West wage gap.

Union wage differential

Workers who are covered by collective bargaining agreements are expected to earn higher wages than workers who are not. There is rich empirical evidence for such a

union wage premium in the international literature (see, e. g., the surveys by Blanchflower and Bryson, 2010; Hirsch, 2004) as well as for the particular case of Germany (see, e. g., Antonczyk *et al.*, 2010). Differences in union coverage between East and West Germany might explain parts of the observed East-West wage gap. In 2010, the share of workers covered by sector- or firm-level collective wage agreements was 13 percentage points lower in East Germany than in West Germany (see Table 1). Hence, we

Table 1: Share of employees by region and by coverage of collective wage agreements

	West Germany	East Germany
none	18%	26%
reference in employment contract	19%	24%
firm-level agreement	7%	13%
sector-level agreement	56%	37%

Source: Hans-Böckler-Stiftung (2015).

expect the union wage differential to contribute largely to the German East-West wage gap. As unionization rates declined faster in East Germany than in West Germany during our observation period, we expect the contribution of the union wage differential to the overall wage gap to increase over time. Furthermore, we expect the union wage differential to play a larger role toward the lower end of the wage distribution, because wage agreements often play a larger role for lower wages than for higher wages.

Inter-industry wage differential

There is strong evidence that similar workers employed in similar firms of different industries earn different wages (Genre *et al.*, 2011; Caju *et al.*, 2010; Gittleman and Pierce, 2011). Efficiency wage models as brought forward by Shapiro and Stiglitz (1984) or Yellen (1984) argue that in industries, in which a worker's effort cannot be directly observed, wages must be set higher in order to assert that the contracted effort is provided (see also Thaler, 1989). Inter-industry wage differentials may also arise, for instance, in the case of industry-specific skill differences (Dickens and Katz, 1986). Inter-industry wage differentials might contribute considerably to the overall

East-West wage gap, as the sectoral structures of the two regions differ substantially. In particular, those industries that pay above-average wages are underrepresented in East Germany. For instance, the employment share in manufacturing is five percentage points lower in East Germany than in West Germany (VGRdL, 2015a,b, see also Figure 2(d)). However, the sectoral structures have somewhat converged during our observation period, and thus we expect the contribution of the industry structure to the East-West wage gap to slightly decrease over time.

Establishment-size wage differential

Larger firms generally pay higher wages than smaller firms. This is a consistent result of the international empirical literature concerned with the establishment-size wage differential (see, e. g., Troske, 1999; Lallemand *et al.*, 2007; Barth and Dale-Olsen, 2011). The result also holds true for Germany (see, e. g., Lehmer and Möller, 2010). Larger firms may choose to pay higher wages in order to reduce their monitoring costs without reducing the worker's incentive to provide the contracted effort (Shapiro and Stiglitz, 1984). If larger firms are more capital-intensive and if there is skill-capital complementarity, larger firms will hire more skilled workers, which results in higher average wages at the firm level (see Hamermesh, 1980). Finally, if a worker's productivity does not vary over firm size and if workers search on the job, profit maximization leads to a positive wage-size relation at the firm level in equilibrium (Burdett and Mortensen, 1998). In Germany, there are large regional differences with respect to establishment size. In 2010, about one third of all West German workers but only one quarter of all East German worker were employed in establishments with at least 250 (regular) employees (Ochsner and Weber, 2014, see also Table 2). In the manufacturing sector, the differences are even larger (49% and 28%, respectively). These figures hardly changed during our observation period. We therefore expect the establishment-size wage differential to be a stable and considerable driving force of the overall East-West wage gap.

Table 2: Share of employees by region and by establishment size

	Whole Economy		Manufacturing	
	West Germany	East Germany	West Germany	East Germany
0–4 regular employees	10%	11%	3%	4%
5–9 regular employees	8%	9%	4%	5%
10–49 regular employees	23%	26%	16%	24%
50–249 regular employees	27%	30%	28%	39%
at least 250 regular employees	31%	24%	49%	28%

Source: Ochsner and Weber (2014). Regular employees are employees with wages subject to social security contributions except for trainees.

Agglomeration wage differential and local price levels

Empirical and theoretical work suggests that wages in agglomerations are higher than wages in rural areas (see, e. g., Andersson *et al.*, 2014; Krashinsky, 2011; Lehmer and Möller, 2010; Lewis and Wheaton, 2002). However, the size of the measured urban wage premium depends on how worker characteristics are controlled for. For instance, highly skilled workers are more often employed in cities. Theoretical explanations for the agglomeration wage differential are provided, for instance, by New Economic Geography: Low transport costs for industrial goods and limited worker mobility can lead to equilibria in which (real) wage differentials persist. The agglomeration wage differential might explain parts of the German East-West wage gap, as East Germany is far less urban than West Germany (see BBSR, 2015): About 43% of the East German area, but only 11% of the West German area are classified as rural. Moreover, average population density and the share of employees working in large cities or towns are much lower in East Germany, while the share of employees working in rather rural areas is much higher (see Table 3).

Blien *et al.* (2009) stress that the urban wage premium disappears if costs of living as well as labor force characteristics are controlled for. Figure 2(e) shows that in East Germany price levels are generally lower than in West Germany, particularly in West German agglomeration areas. We differentiate between the agglomeration wage

Table 3: Share of employees by region and by settlement pattern of their workplace

	West Germany	East Germany
large city	36%	42%
town	42%	8%
suburban region	13%	23%
rural region	9%	28%

Source: BBSR (2015); BA (2011).

differential and wage differences arising from different local price levels, and thus we expect the agglomeration wage differential itself to have a rather small contribution to the overall real wage gap. As settlement patterns hardly change within 15 years, we expect this contribution to be very stable over time. In contrast, the findings by Blien *et al.* (2009) suggest that local price differences should play a major role in explaining the overall East-West wage gap. We expect local price levels to be important, particularly for the wage gap in the upper part of the wage distribution, where wages are more likely to be individually bargained. We expect workers who bargain over their wages themselves to take variations in local costs of living into account. In contrast, collective agreements, which are more important for lower wages, have few opportunities to address such variations.

3. Empirical Strategy

In order to explore the contributions of the various factors to the observed German East-West wage gap, we first estimate augmented Mincerian wage equations (Mincer, 1974) separately for workers in East and in West Germany in a given year. These wage equations account for the six factors discussed in section 2, including local price levels, and further individual, establishment, and regional wage determinants. As we are concerned with the variation of the wage gap over the whole wage distribution, we estimate the wage equations using unconditional quantile regressions, also known as RIF-regressions (Firpo *et al.*, 2007, 2009, 2011). We then use the estimated RIF-coefficients

to decompose the East-West wage gap in a standard Oaxaca-Blinder decomposition (Oaxaca, 1973; Blinder, 1973). Standard errors are obtained via bootstrapping the whole procedure 100 times.

To facilitate the analysis, we focus on the 10^{th}, 30^{th}, 50^{th}, and 70^{th} quantiles. The 90^{th} quantile of either wage distribution, East or West, exceeds the assessment ceilings, and its inspection thus would require to impute wages (see below). We furthermore explore whether the contributions of the different factors change over time. Hence, we perform the estimation and decomposition steps separately for each year in the period from 1996 to 2010. We deliberately restrict ourselves to a period when the wage gap was relatively stable so that the size of the overall wage gap is comparable across years.

3.1. The wage equation

In our wage regressions, the dependent variable is the log of the daily gross wage. Wage data are top-coded at assessment ceilings that vary between East and West Germany as well as over time. Each year, about 8% of all wages in East Germany and 25% of all wages in West Germany exceed the East German assessment ceiling. Attempts have been made to impute wages above the assessment ceilings (see, e. g., Büttner and Rässler, 2008). However, imputation of missing wages assumes that the likelihood of a wage to be unobserved does not depend on the wage level (missing-at-random assumption, see, e. g., Gelman and Hill, 2006), which is not the case here. We therefore refrain from imputing wages. Note that this does not harm our analysis, because we apply unconditional quantile regressions instead of ordinary least squares. Given the high share of West German wages above the East German assessment ceiling, we also do not decompose wages in the upper quartile of the wage distribution.

The standard wage equation proposed by Mincer (1974) regresses log wages on years of schooling, years of labor market experience, and the square of the latter. In our data, we do not observe years of schooling, but rather the skill level. We distinguish the four

groups low skilled (without occupational degree), medium skilled (with occupational degree), high skilled (with university degree), and unknown skill.[1] Unlike in the U.S., it is not possible to translate the observed skill level into years of education because pupils in Germany may leave school after 9, 10, 12, or 13 years of schooling, depending on the degree and the federal state (Büttner and Thomsen, 2015), and because vocational training and tertiary education vary considerably between disciplines. Like years of schooling, we do also not observe the actual years of labor market experience. Entry into the labor market is unobserved in our data for workers starting their employment careers before 1975 in the Federal Republic of Germany or before 1992 in the former German Democratic Republic. Measured labor market experience is thus downward biased for a large portion of workers, especially in East Germany. If years of labor market experience are not directly observable, they are usually approximated by age minus years of education minus six years. As mentioned before, we do not observe the years of education and thus cannot adopt this measure. Thus, we follow Steiner and Wagner (1997) and other studies and approximate labor market experience simply by a worker's age and age squared.

We augment the wage equation by several variables to account for the different kinds of factors discussed in section 2. In order to allow for nonlinear effects, all metric variables are included as linear and squared terms. The gender wage gap is accounted for by a dummy being one if the worker is female. The union wage gap is captured by a categorial variable distinguishing whether wage-setting in an establishment is subject to a sector-level, firm-level, establishment-level, or no collective agreement.[2] If sector-level agreements play a role, we further distinguish whether the establishment has signed the agreement and is thus strictly bound to it, or whether the establishment voluntarily refers to the agreement' regulations in its labor contracts. Inter-industry wage

[1] We use the highest skill level observed up to period t. For about 10% of the observations of a given year we do not observe any skill information. We classify these observations as unknown skill level.

[2] Establishment-level agreements are negotiated not by unions but by work councils (*Betriebsräte*). Such agreements may set wage-schemes only if neither a sector-level nor a firm-level collective agreement applies.

differentials are captured by a variable distinguishing eight sectoral branches according to the German Classification of Economic Activities, Edition 1993 (see Federal Statistical Office Germany, 2003): agriculture & fishing (01-05); mining & energy (10-14 & 40-41); manufacturing (15-37); construction (45); trade, hotels & transport (50-64); financial and real estate services (65-70); services for enterprises (71-74); and public and private services (75-99). Size differentials are accounted for by the number of regular workers employed at the establishment on June 30 in a given year. Differences in agglomerations are represented by a district's settlement pattern, which distinguishes large cities, towns, suburban regions, and rural regions (see BBSR, 2015).

Furthermore, we account for differences in local price levels, as they might imply different reservation wages. Price indices for the German district level are available for the year 2008 (see BBSR, 2009). We adjust these data to the territorial boundaries of the year 2010 using population-weighted averages of price levels. We have to drop the six districts Dessau-Rosslau, Anhalt-Bitterfeld, Harz, Jerichower Land, Salzlandkreis, and Wittenberg, because for these district consistent price-level data cannot be constructed. We then extrapolate local price levels using GDP-deflators from the state (*Bundesländer*) level, which can be computed with official data (see VGRdL, 2015b). This procedure combines the well defined cross-sectional variation in prices with observed inflation rates, but comes at the cost of assuming that regions within a particular state are subject to identical inflation rates.[3]

Apart from the Mincerian variables and the factors from section 2, including local price levels, we control for further variables to explain as much of the observed wage variation as possible. At the individual level, we control for a worker's nationality (German, non-German), her occupation (production, construction, engineering, services, and other),[4] and her current job position (unskilled, skilled, foreman, employee). As wages usually

[3] An alternative to this procedure might be multiple imputation, which has been applied to cross-sectional German price data by Blien *et al.* (2009). However, our missing data pattern (complete data in one year and all missing in remaining years) does not fully meet the requirements for multiple imputation, which is why we refrain from using it.

[4] This classification closely follows the official classification of *Berufsbereiche* by Bundesanstalt für Arbeit (1988).

increase faster at the beginning of an employment spell, we also include two dummies identifying workers whose employment contracts have lasted for at least one year or three years, respectively. We are unable to control for longer employment durations because of the left-censoring of East-Germans' employment records in the early 1990s. At the establishment level, we control for overall productivity, which we approximate by revenue per regular worker, and the establishment's position within a larger organization. We distinguish the following settings: single units, headquarters, center spots, and subsidiaries. Finally, wages may be subject to wage spillovers from nearby firms, even from other industries. In general, we expect a higher share of engineering or manufacturing in overall employment at the district level to exert a positive wage effect on all wages in the same district, while a higher share of services may exert a negative effect. We therefore regress a worker's log wage also on these three employment shares of the worker's district of work. Again, all metric variables are included as linear and as squared terms.

3.2. RIF regression

The wage equation may be estimated using conditional quantile regressions (Koenker and Bassett, 1978) to obtain parameter estimates over the log-wage distribution. However, decompositions of wage differentials over the wage distribution using these estimates, as, e. g., proposed by Machado and Mata (2005), do not allow for detailed decomposition at the level of single variables. This is because the coefficients from a conditional quantile regression do not correspond to the marginal effect of a small change in variables X on the τ-th quantile of the unconditional distribution of the log-wage Y. We therefore employ unconditional quantile regressions, or RIF regressions, proposed by Firpo *et al.* (2007, 2009).

Estimation is based on the re-centered influence function (RIF). For quantile q_τ, the

RIF is given by

$$RIF(Y, q_\tau) = q_\tau + IF(Y, q_\tau) \tag{1}$$

where $IF(Y, q_\tau)$ denotes the influence function

$$IF(Y, q_\tau) = \frac{\tau - \mathbb{1}\{Y \leq q_\tau\}}{f_Y(q_\tau)} \tag{2}$$

where $\mathbb{1}\{\bullet\}$ denotes an indicator function and $f_Y(q_\tau)$ denotes the marginal density function of the log-wage Y at quantile q_τ. $f_Y(q_\tau)$ is estimated using kernel methods. We apply an Epanechnikov kernel with a band width of 0.06.

Firpo *et al.* (2009) define the conditional expectation of the RIF given explanatory variables X as the RIF regression model. They show that, in contrast to the conditional quantile regression model, parameters of the RIF regression model correspond to the marginal effects of small changes in X on the unconditional quantile. Therefore, under the assumption that the conditional expectation of $RIF(Y, q_\tau)$ given X is linear in X, coefficients obtained with the RIF regression model may be used in an otherwise standard Oaxaca-Blinder-decomposition. RIF coefficients even allow for detailed decompositions of differentials over the wage distribution (Firpo *et al.*, 2007, 2011).

RIF regressions have already been successfully applied in a large number of studies, among others in the context of the gender wage gap (Chi and Li, 2008; Kassenböhmer and Sinning, 2014; Magnani and Zhu, 2012), the black-white wage gap (Heywood and Parent, 2012), downward nominal wage rigidity (Beissinger and Stüber, 2012), the wealth distribution (Lindner, 2015), education economics (Chapman and Sinning, 2014; Ding and Lehrer, 2011; Ehrenberg and Webber, 2010), and intergenerational mobility (Schnitzlein, 2015).

3.3. Oaxaca-Blinder decompositions of wage differentials over the wage distribution

Let $\bar{X}^r, r = \{E, W\}$, be the average worker, establishment, and regional characteristics in East and West Germany, respectively. Let $\hat{\beta}_\tau^r$ be the estimated coefficients from the group-specific RIF regression models at quantile q_τ^r of the group-specific log-wage distributions. Then, the East-West log-wage gap at quantile q_τ, $\Delta_\tau = q_\tau^W - q_\tau^E$, may be decomposed into a composition effect and a wage structure effect using the technique proposed by Oaxaca (1973) and Blinder (1973):

$$\hat{\Delta}_\tau = \underbrace{\left(\bar{X}^W - \bar{X}^E\right)\hat{\beta}_\tau^W}_{\text{composition effect}} + \underbrace{\bar{X}^E\left(\hat{\beta}_\tau^W - \hat{\beta}_\tau^E\right)}_{\text{wage-structure effect}} \tag{3}$$

The composition effect reflects that part of the wage gap that can be attributed to differences in observed worker, establishment, and regional characteristics between East and West Germany. The wage structure effect is interpreted as that part of the wage gap that is due to differences in the returns to these characteristics between East and West Germany. For instance, differences in skills between East and West German workers contribute to the composition effect, while differences between the returns to a, say, university degree contribute to the wage-structure effect.

In our decomposition, we define West German workers as the reference group. We thus assume that their wages would not change due to some general equilibrium effects were there no differences between East and West Germany. Some authors (e. g., Neumark, 1988) propose to account for potential general equilibrium effects by applying coefficients that are obtained from a pooled regression. However, this would likely result in an overestimation of the composition effect (Elder *et al.*, 2010).

The composition and wage-structure effects can be further decomposed into contributions of each single variable of the underlying wage regression. However, such detailed decompositions are subject to methodological limitations (see Jones, 1983; Oaxaca and

Ransom, 1999). For categorial variables, these limitations emerge from the arbitrary choice of the reference group. Consider, for instance, our industry variable: Whether we use manufacturing or construction as the reference group in our wage regressions neither affects the composition effect nor the wage-structure effect. It also does not alter the contribution of the variable "industry structure" to the composition effect. It does, however, affect the estimated contribution of the variable "industry structure" to the wage-structure effect. It also alters the contribution of a specific industry, manufacturing say, to both the composition effect and the wage-structure effect. Further limitations arise from the arbitrary transformation of continuous variables. Consider, for instance, the operationalization of experience: While we simply use a worker's age, other studies employ a measure of age minus years of schooling minus six years. Either operationalization would lead to different contributions of the variable "experience" to the wage-structure effect.

Several procedures have been proposed to overcome the reference-group problem, for instance by Horrace and Oaxaca (2001), Gardeazabal and Ugidos (2004), or Yun (2005), but these come at the cost of potentially leaving the decomposition results without a meaningful interpretation (Firpo *et al.*, 2011). We thus provide detailed decomposition results only for the composition effect and only for variables (e. g., industry structure), and not for the variables' single values (e. g., the construction sector). This is sufficient, because the variables as a whole and not their single values are of interest in our study.

3.4. Selection issues

The Oaxaca-Blinder decomposition assumes the covariates to be exogenous. This assumption may be violated if workers self-select themselves into jobs in either East or West Germany. The leading example for this type of self-selection is the self-selection of workers into union membership. The union wage gap literature addresses this issue using control function methods or the Heckman (1979) selection model. Both approaches

rely on the exclusion restriction that variables are observed, which affect the selection into one group or the other but not the wage outcome. Such an exclusion restriction is often difficult to justify (Blanchflower and Bryson, 2010; Hirsch, 2004). Moreover, Lewis (1986) concludes that the applied methods often yield unreliable results. As a consequence, the issue of self-selection is often neglected and the covariates are treated as if they were exogenous (Firpo *et al.*, 2011; Hirsch, 2004).

Assuming that we could justify the exclusion restriction in our setting, we would need to incorporate the selection correction into the quantile decomposition model. First attempts in this regard have been made (e. g., Albrecht *et al.*, 2005; Nicodemo, 2009; Chzhen and Mumford, 2011; Chzhen *et al.*, 2012), but these have been limited by various methodological issues (see, e. g., Neuman and Oaxaca, 2004). As a workaround, some authors (e. g., Kassenböhmer and Sinning, 2014) apply selection correction just for the mean, which is somewhat easier to implement. They demonstrate that self-selection does not play a role at the mean and then continue with their quantile decompositions without correcting for self-selection. In our case, an analysis at the mean would require to impute wages above the assessment ceiling first. As argued above, we refrain from this imputation because of the missing data pattern. We thus do not correct for self-selection in our analysis and leave the development of appropriate approaches in the context of quantile decomposition techniques to future research.

4. Data

Our empirical strategy relies on comprehensive worker, establishment, and regional data for Germany. We therefore employ the Linked-Employer-Employee Data (LIAB) cross-sectional model 2 1993–2010 (LIAB QM2 9310) from the Institute for Employment Research (IAB).[5] The LIAB is a rather novel, large, and comprehensive data set.

[5]Data access was provided via on-site use at the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB) and subsequently remote data access (project fdz747).

It combines yearly survey data on German establishments with daily administrative spell data on employed and unemployed persons (see Heining *et al.*, 2014, 2013; Fischer *et al.*, 2009, for details).

The LIAB QM2 9310 covers the period 1993 to 2010. It comprises all establishments participating in the IAB Establishment Panel of a particular year, and any worker employed in at least one of the participating establishments on June 30 of the same year. The IAB Establishment Panel has been conducted since 1993 in West Germany and since 1996 in East Germany. The sample is drawn stratified on establishment size classes and on industries, including the public sector. Larger firms are oversampled, but weights provided with the data allow for representative analyses. The sample is regularly augmented to correct for panel attrition, the closure of existing establishments and the founding of new establishments. In 1996, the IAB Establishment Panel covered over 4,000 establishments each in East and West Germany. In 2010, it covered almost 10,000 West German establishments and over 6,000 East German units. The IAB Establishment Panel provides information on an establishment's workforce and revenues, its wage-setting regularities, and its position within larger organizations (if any). We divide revenues by the number of regular workers to obtain a measure of productivity at the establishment level.

For each worker employed in at least one of the participating establishments on June 30, worker characteristics are taken from administrative data sources. They provide detailed information on an employee's gender, citizenship, age, skill level, and occupation. They also comprise information on the current job in the surveyed establishment, including daily gross wages, full-time/part-time work, the job position, tenure, and the place of work. All variable values refer to June 30 of the given year. The data on employed workers stem from mandatory notifications by employers to the social security system. The data, especially the wage information, are of extraordinary high quality, as mis-notifications are heavily fined.

The linkage of establishment and worker data in the LIAB is sometimes of limited

quality (Jacobebbinghaus, 2008). That results from the use of two different firm identifiers. The LIAB links establishment and worker data via an official establishment registration figure, while establishments within the IAB Establishment Panel are identified by an own panel identifier. If an establishment is sold the official establishment registration figure changes but the panel identifier does not. As a result, total employment according to the IAB Establishment Panel may then differ from the sum of employees registered at the sold establishment unit. Other establishment characteristics may differ as well, resulting in potentially serious measurement errors. To improve the quality of the linkage, we drop establishments if the wave code indicates that the unit surveyed in year t differs from the unit surveyed last year or the second-to-last year. We also drop establishments for which the state (*Bundesland*) according to the IAB Establishment Panel differs from the linked employees' workplace. Finally, we drop establishments when total employment according to the IAB Establishment Panel differs from the total number of linked employees and if the difference exceeds the thresholds proposed by Jacobebbinghaus (2008).

In order to facilitate a meaningful analysis of the East-West wage gap we further constrain the sample. First, our measure of productivity at the establishment level necessitates that we restrict our sample to establishments generating revenues. Second, we observe only daily gross wages and thus have to restrict our sample to full-time workers. Third, trainees in the apprenticeship system actually do not earn wages but receive compensations. We thus drop workers below the age of 25 and workers who are explicitly registered as trainees. Finally, we drop the very small group of workers who work at home, as their compensation schemes and characteristics may differ from those of regular workers.

Our final sample consists of about 9.7 million observations in 15 years. They comprise of about 7.5 million observations in West Germany and 2.2 million observations in East Germany. On average, we observe almost 650,000 workers employed in about 5,400 establishments each year.

5. Empirical Results

We first present descriptive statistics from our sample on the structural differences between East and West Germany at the level of workers, establishments, and regions. We then briefly discuss the results from our unconditional quantile regressions, or RIF regressions. Finally, we present the decomposition results, which weight the structural differences with the estimated coefficients.

5.1. Structural differences between East and West Germany

For our sample, we observe well-known structural differences between East and West Germany. Table 4 provides descriptive statistics on these differences for the years 1996 and 2010 at the worker level. Compared to West Germany, the share of female employees in East Germany is larger while the share of non-German workers is much lower. East German workers are on average slightly older and better skilled. They work more often in service or construction occupations and less often in production or as engineers than West German workers. We also observe a higher share of rather new labor contracts in East Germany. The East-West differences in worker characteristics are stable over time, though differences in occupations and tenure become smaller.

Significant differences also exist at the establishment level (see Table 5). East German establishments are smaller and less productive than West German ones, though they have caught up during our sample period. Surprisingly, the average establishment size decreases over time in both regions, which probably reflects the repeated extension of the IAB Establishment Panel to more (and smaller) firms over time. Furthermore, our sample reflects the well-known differences in the industry structure and the lower union density in East Germany. Note that the fraction of establishments subject to firm-level or sector-level collective agreements decreases over time in both regions, but that the decrease is larger in East Germany. Additionally, our data reflect the relative absence of headquarters in East Germany.

Table 4: Worker characteristics in East and West Germany

	1996		2010	
	West	East	West	East
Female	16.9%	27.9%	17.0%	30.8%
Non-German	12.5%	2.0%	8.4%	1.3%
Age (in years)	41.1	42.0	44.2	45.0
	(9.8)	(9.4)	(9.5)	(10.0)
Skill				
Unknown	3.1%	9.8%	4.5%	6.3%
Low skilled	21.8%	5.4%	11.7%	3.8%
Medium skilled	64.6%	70.5%	70.3%	75.7%
High skilled	10.5%	14.3%	13.5%	14.2%
Occupational status				
Unskilled	35.2%	15.2%	29.5%	17.6%
Skilled	27.3%	45.8%	27.7%	43.2%
Foreman	2.5%	2.9%	2.6%	1.7%
Employee	35.0%	36.1%	40.2%	37.5%
Occupation				
Construction	1.0%	8.8%	1.1%	2.3%
Production	53.0%	37.0%	46.1%	44.1%
Engineering	16.3%	12.3%	16.6%	9.8%
Services	29.2%	37.1%	34.1%	41.3%
Other	0.6%	4.8%	2.2%	2.5%
Tenure $>$ 1 year	94.9%	87.0%	94.4%	91.1%
Tenure $>$ 3 years	78.8%	63.6%	82.1%	77.1%
Workers	463,457	209,689	396,411	111,947

Notes: Standard deviations for metric variables in parentheses.
Source: LIAB QM2 9310.

Finally, structural differences can also be observed at the district level (see Table 6). As already noted in section 2, East Germany is more rural than West Germany and exhibits lower local price levels. However, East German local price levels converged slightly toward West German ones, which should have induced a convergence in nominal reservation wages as well.

The structural differences in our sample at the worker, establishment, and regional levels give rise to a considerable East-West wage gap throughout the wage distribution (see Figure 2). In 2010, the East German median wage in our sample was 35% (about

Table 5: Establishment characteristics in East and West Germany

	1996		2010	
	West	East	West	East
Establishment size[a)]	416.9	131.4	153.2	65.6
	(981.4)	(281.9)	(1156.7)	(171.1)
Productivity[b)]	213.9	108.4	207.9	141.8
	(531.5)	(132.3)	(381.7)	(192.3)
Industry				
Agriculture	0.6%	5.5%	1.7%	3.9%
Mining & energy	2.7%	2.4%	2.2%	1.3%
Manufacturing	50.9%	24.9%	31.7%	45.4%
Construction	11.1%	26.6%	8.9%	10.7%
Trade, hotel & transport	23.5%	21.6%	29.2%	17.4%
Financial & real estate services	0.9%	2.7%	1.8%	2.5%
Services for enterprises	6.0%	7.6%	12.3%	8.6%
Public & private services	4.1%	8.6%	12.2%	10.2%
Collective agreements				
No agreement	11.0%	29.6%	23.3%	35.2%
Establishment-level only	2.7%	4.1%	2.9%	3.8%
Firm-level	11.1%	17.7%	5.6%	7.4%
Sector-level, binding	75.2%	48.6%	42.0%	22.4%
Sector-level, by reference	0.0%	0.0%	26.1%	31.1%
Establishment type				
Single unit	62.1%	80.7%	77.0%	83.6%
Headquarter	14.1%	5.3%	7.5%	3.3%
Subsidiary	22.8%	13.4%	14.8%	12.6%
Center spot	0.9%	0.6%	0.7%	0.5%
Establishments	1,280	1,909	3,249	2,224

Notes: Standard deviations for metric variables in parentheses. a) Number of regular workers. b) Revenue per regular worker in 1.000 Euro.
Source: LIAB QM2 9310.

42 Euro per day) short of the West German median wage. The gap was 39% or 40 Euro per day at the 30%-quantile and 31% or 44 Euro per day at the 70%-quantile. Wages converged at most slightly and only until the early 2000s. Since then the wage gap has increased again.[6] The median wage gap, for instance, was 7.5 percentage points larger in 2010 than in 1996.

[6]Brück and Peters (2009) report a simultaneous divergence in terms of household income.

Table 6: District characteristics in East and West Germany

	1996		2010	
	West	East	West	East
Settlement pattern				
Large city	19.7%	13.6%	17.9%	13.6%
Town	40.9%	7.4%	39.8%	7.4%
Suburban	21.2%	29.6%	23.5%	29.6%
Rural	18.3%	49.4%	18.8%	49.4%
Employment shares				
Manufacturing	35.5%	34.2%	29.3%	28.7%
	(7.7)	(6.3)	(7.3)	(7.2)
Engineering	6.6%	5.1%	6.4%	4.9%
	(2.4)	(1.8)	(2.5)	(1.6)
Services	55.9%	54.5%	61.4%	61.5%
	(7.1)	(6.5)	(7.4)	(7.2)
Local price level[a)]	84.9	79.0	94.1	89.5
	(4.8)	(2.3)	(5.2)	(2.4)
Districts	279	81	319	81

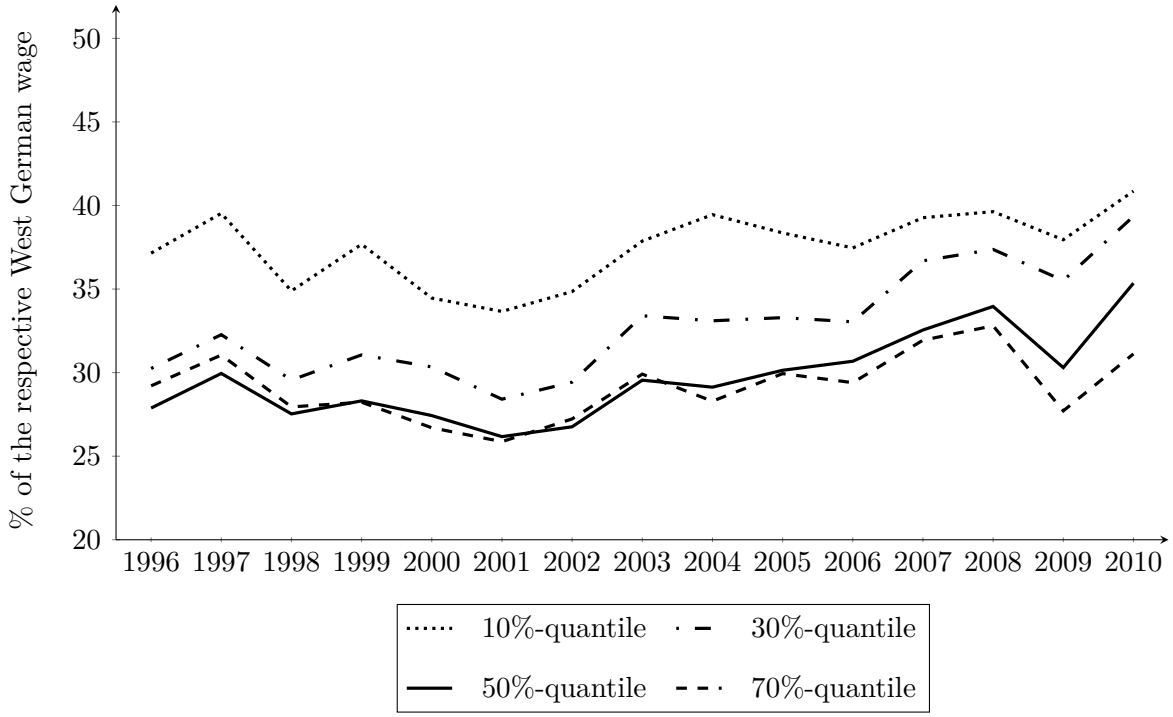
Notes: Standard deviations for metric variables in parentheses. a) Bonn 2008 = 100.
Source: LIAB QM2 9310. Local price levels derived using data from the BBSR (2009).

5.2. RIF regression results

We now briefly review the RIF regression results. We do not present the detailed estimation results because of space constraints. Complete RIF regression results are available from the authors upon request.

The results from the RIF regressions indicate that the wage variation patterns discussed in section 2 exist in both East and West Germany: First, female workers earn significantly less than male workers. This relationship is very stable over time and holds for all wage quantiles. Second, establishments with any kind of wage agreement pay more than those without. The difference is lowest for agreements at the establishment level and highest for (implicit or explicit) sector-level agreements. Third, there is evidence for significant inter-industry wage differentials. The highest wages are earned in the sectors financial & real estate services, mining & energy, and manufacturing. Fourth, larger establishments pay significantly higher wages throughout our observation period

Figure 2: The East-West wage gap in % of the respective West German wage



Source: LIAB QM2 9310.

and over all wage quantiles. Finally, the settlement pattern yields ambiguous results. The reason might be that, as expected, the price variable absorbs most of the agglomeration effect. The marginal effect of the price variable itself is predominantly positive, i. e., higher local price levels are reflected in higher nominal wages.

The control variables show reasonable signs as well: Among others, we observe positive but diminishing returns to age (experience), as well as positive returns to skills (schooling), and, in general, to tenure. We also estimate a stable positive and convex relationship between individual wages and productivity in the narrow sense, i. e., revenue per worker at the establishment level. Additionally, a higher employment share in engineering goes along with higher wages for any worker in the same district.

5.3. Decomposition results

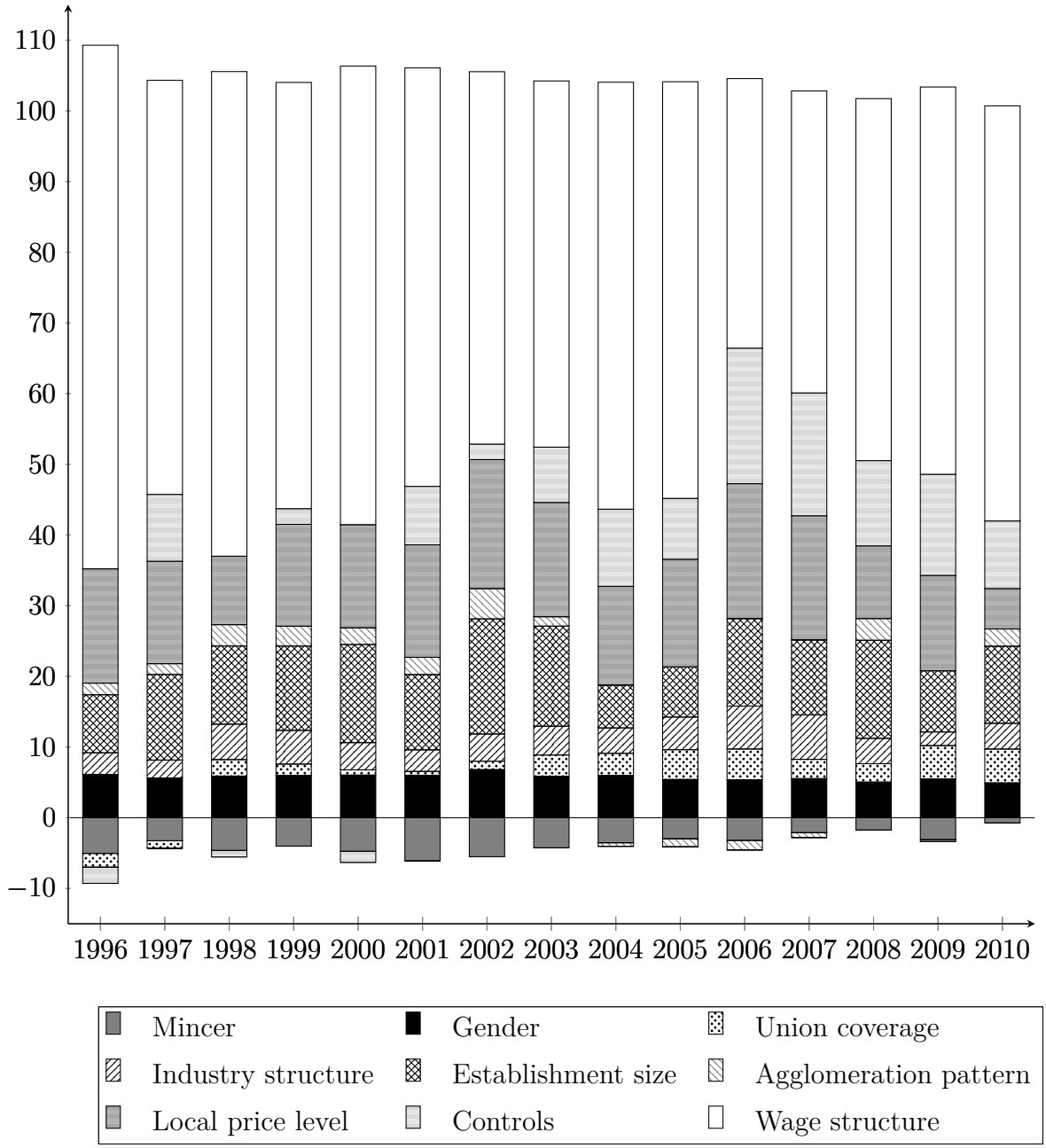
We now turn to our decomposition results, which are shown for the wage gap at the median in each year from 1996 to 2010 in Figure 3.[7] In order to facilitate interpretation, we combine our variables into eight groups and display them as stacked rectangles: *Mincer* (containing age, age squared, and the skill level), the six factors described in section 2, and a catch-all group *controls* that contains all the control variables mentioned in section 3. Each rectangle depicts the contribution of the particular group of characteristics to the overall log-wage gap in percentage points. The *wage-structure* part, depicted by the white rectangles in Figure 3, reflects the part of the wage gap that is not due to differences in characteristics between East and West Germany but due to different returns to these characteristics (see equation (3)). It varies considerably over time and accounts for about 57% of the observed wage gap on average. Hence, between 1996 and 2010, the median East-West wage gap at the individual level, after accounting for differences in worker, establishment, and regional characteristics, was one third to one half smaller than aggregate data suggest.

We proceed by discussing each of the eight different groups of variables in more detail. Consider first the *Mincerian* wage determinants (age and skills), indicated by the gray bars in Figure 3. The better skill structure of East German workers compressed the wage gap on average by 3.7% at the median and by even 5.2% at the 70%-quantile. If the formal qualifications and experience of East German workers would have been as low as for West German workers, the East-West wage gap would have been even larger.

Second, the contribution of the *gender wage differential* (black bars in Figure 3) to the East-West wage gap is, as expected, of considerable size and very stable over time. If the share of female employees in East Germany would have been as low as in West Germany, the overall median wage gap would have been 5.7% lower on average. The contribution is even larger toward both ends of the wage distribution (9.0% at the

[7] Similar figures for the 10%-, 30%- and 70%-quantiles are presented in Figures 4 to 6 in the appendix.

Figure 3: Decomposition results: Share of the East-West wage gap at the median explained by differences in average characteristics



Reading example: Differences in the share of female employees between East and West Germany explain about 5% of the observed East-West wage gap in 2010.
Source: LIAB QM2 9310.

10%-quantile and 7.0% at the 70%-quantile; see Figures 4 and 6 in the appendix). Hence, the fact that women are generally paid less than men, combined with the fact that in East Germany the share of women among the employed is larger, explains a considerable share of the German East-West wage gap.

Third, the contribution of the *union wage differential* (dotted pattern in Figure 3) differs between different quantiles of the wage distribution and also varies over time. If unionization rates would have been equal between East and West Germany, the median wage gap would have been about 2.2% lower on average. The effect would be much larger for lower quantiles (8.9% for the 10%-quantile and 3.8% for the 30%-quantile; see Figures 4 and 5 in the appendix). This is due to the fact that wages at the lower end of the wage distribution are more likely to be subject to collective agreements than those in upper percentiles and that unions usually try to compress the wage structure. The contribution of the union wage differential to the East-West wage gap has increased during our observation period, which reflects that the already smaller unionization rate in East Germany has decreased more rapidly than in West Germany.

Fourth, the impact of the *inter-industry wage differential* (black north-east lines in Figure 3) on the median wage gap amounts on average to 4.0%. This contribution varies considerably over the business cycle, reaching its peak of 6.3% during the boom in 2007 and its trough of 1.9% during the Great Recession in 2009. The same pattern is observed at other points in the wage distribution as well. Hence, the part of the East-West wage gap attributable to different sectoral structures depends on sector-specific fluctuations over the business cycle. It is nevertheless substantial on average.

Fifth, the *establishment-size differential* (cross-hatch pattern in Figure 3) contributes to a large extent to the East-West wage gap. The average contribution to the median gap amounts to 11.2%. However, it is smaller at both ends of the wage distribution (5.6% at the 10%-quantile and 8.7% at the 70%-quantile; see Figures 4 and 6 in the appendix). This pattern might be explained as follows: Low wages are primarily determined by implicit lower wage bounds arising from labor market and social welfare institutions, and by collective agreements. These lower bounds apply irrespective of the establishment size. High wages are often individually bargained. The individual bargaining outcome applies irrespective of the establishment size as well. Hence, it is rather wages in the middle of the wage distribution that depend on establishment size.

Sixth, the *agglomeration wage differential* (indicated by gray north-west lines in Figure 3) contributes, as expected, only slightly to the wage gap, because we consider differences in local price levels separately. If East Germany would have been as urban as West Germany during the observation period, the East-West wage gap would have been about 1.4% smaller on average.

Seventh, differences in *local price levels* (indicated by the dark gray horizontal pattern) make a considerable contribution to the nominal wage gap: If local price levels in East Germany would have been as high as in West Germany during our sample period, the median wage gap would have been about 14.3% smaller on average. Hence, the real wage gap is actually smaller than the nominal gap depicted in Figure 2. This effect increases over the wage distribution. It amounts to 19.0% at the 70%-quantile but to only 8.5% at the 10%-quantile (see Figures 4 and 6 in the appendix). This observation is due to the fact that wages toward the upper end of the distribution are more often subject to individual bargaining that takes costs of living in a particular place of work into account, while wages at the lower end of the wage distribution are more often determined by an implicit wage floor that arises from the German welfare system. This implicit wage floor is about the same in all German districts, because social welfare does not fully account for regional price differences.

Finally, the entirety of our *control* variables (light gray horizontal pattern in Figure 3) contributes considerably to the overall East-West wage gap, whether measured at the median or somewhere else in the wage distribution. Their contribution even increases over time. Among the control variables, firm-level labor productivity is a comparably important determinant of the East-West wage gap. However, their contribution to the median wage gap varies between 2% and 6%, and is thus at most as large (or small) as the contribution of the gender wage differential. Thus, compared to other factors discussed in this paper, notably local price differences and establishment size effects, differences in establishment-level labor productivity are only of minor importance in explaining the East-West wage gap.

6. Conclusion

Almost 25 years after reunification, there is still a considerable wage gap between East and West Germany. Wage convergence came virtually to a halt by 1995. We use a large linked employer-employee data set, which we supplement with regional variables measured at the district level in order to decompose the persistent German East-West wage gap into composition and wage structure effects. Specifically, we focus on differences in worker, establishment, and regional characteristics. We trace the contributions of these differences to the East-West wage gap over the period from 1996 to 2010 and across the wage distribution. We obtain our results from a standard Oaxaca-Blinder decomposition, where we use parameter estimates of augmented Mincerian wage equations, which we have estimated with unconditional quantile regressions.

Our results confirm and extend earlier results on the East-West wage gap: After the transition period had phased out in the mid-1990s, the wage gap declined only slightly further and even started to increase again in the early 2000s. At the median, about one fourth of this persistent wage gap can be attributed to local price level differentials (14%) and differences in establishment size (11%). In contrast, establishment-level labor productivity accounts for only 2%–6% of the median wage gap. This figure is within the range of contributions of other factors of wage variation, like the share of female workers (6%), the sectoral structure (4%), or union coverage (2%). After separating out price level differentials, agglomeration patterns account for only 1% of the observed wage gap. Note that the median East-West wage gap is dampened by about 4% because East German workers possess on average higher human capital. Altogether, structural differences explain one third to almost one half of the observed East-West wage gap.

The decomposition results are fairly stable across the wage distribution, though the expected differences arise: Toward the bottom of the wage distribution, differences in union coverage play a larger role, while toward the top of the wage distribution,

differences in local price levels, skills, and experience become more important. The results are also quite stable over time. Minor exceptions are the contribution of the sectoral structure, which varies over the business cycle, and the contribution of union coverage, which increases over time as union coverage in East Germany declines relative to the union coverage in West Germany. In contrast, we do not find evidence that the Hartz reforms, Germany's major labor market reforms that were implemented in the years 2003 to 2005, had an effect on either the size of the wage gap or the relative contribution of particular characteristics to the East-West wage gap.

These findings lead to three major conclusions. First, the persistent East-West wage gap observed today results only to a very limited extent from productivity differences in the narrow sense, i. e., differences in input-output ratios at the establishment level. It rather reflects differences in local price levels and persistent structural differences. Accounting for such structural differences reduces the East-West wage gap by one third to one half. Second, the major role of local price levels in explaining the East-West wage gap implies that real wage convergence is much more advanced than nominal wage data suggest. Third, as the last decade has shown, the structural differences are comparably stable over time and there is little evidence that they will cease in the near future. From an aggregate perspective, we thus do not expect East German wages to converge considerably toward West German wage levels in the years to come.

References

Al-Farhan, U. F. (2010). Changes in the Gender Wage Gap in Germany During a Period of Rising Wage Inequality 1999–2006: Was it Discrimination in the Returns to Human Capital? *SOEPpaper 293*.

Albrecht, J., van Vuuren, A. and Vroman, S. (2005). Counterfactual distributions with sample selection adjustments: Econometric theory and an application to the Netherlands. *Labour Economics*, **16** (4), 383–396.

Andersson, M., Klaesson, J. and Larsson, J. P. (2014). The sources of the urban wage premium by worker skills: Spatial sorting or agglomeration economies? *Papers in Regional Science*, **93** (4), 727–747.

Antonczyk, D., Fitzenberger, B. and Sommerfeld, K. (2010). Rising wage inequality, the decline of collective bargaining, and the gender wage gap. *Labour Economics*, **17** (5), 835–847.

Aumann, B. and Scheufele, R. (2010). Is East Germany Catching Up? A Time Series Perspective. *Post-Communist Economies*, **22** (2), 177–192.

Barrell, R. and Velde, D. W. T. (2000). Catching-up of East German labour productivity in the 1990s. *German Economic Review*, **1** (3), 271–297.

Barth, E. and Dale-Olsen, H. (2011). Employer size or skill group size effect on wages? *Industrial and Labor Relations Review*, **64** (2), 341–355.

Beissinger, T. and Stüber, H. (2012). Does downward nominal wage rigidity dampen wage increases? *European Economic Review*, **56** (4), 870–887.

Blanchflower, D. G. and Bryson, A. (2010). The wage impact of trade unions in the UK public and private sectors. *Economica*, **77** (305), 92–109.

Blien, U., Gartner, H., Stüber, H. and Wolf, K. (2009). Regional price levels and the agglomeration wage differential in western Germany. *The Annals of Regional Science*, **43** (1), 71–88.

Blinder, A. S. (1973). Wage discrimination: reduced form and structural estimates. *Journal of Human Resources*, **8** (4), 436–455.

Brück, T. and Peters, H. (2009). 20 years of German unification: evidence on income convergence and heterogeneity. *IZA Discussion Paper 4454*.

Bundesagentur für Arbeit (BA) (ed.) (2011). *Beschäftigungsstatistik, Sozialversicherungspflichtig Beschäftigte nach Kreisen und kreisfreien Städten, Stichtag 30. Juni 2010*. Nuremberg.

Bundesanstalt für Arbeit (ed.) (1988). *Klassifizierung der Berufe. Systematisches und alphabetisches Verzeichnis der Berufsbenennungen*. Nuremberg.

Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) (ed.) (2009). *Regionaler Preisindex*, *Berichte*, vol. 30. Bonn.

Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) (ed.) (2015). *Indicators, Maps and Graphics on Spatial and Urban Monitoring. INKAR 2014.* Bonn.

Burdett, K. and Mortensen, D. T. (1998). Wage Differentials, Employer Size, and Unemployment. *International Economic Review*, **39** (2), 257–273.

Büttner, B. and Thomsen, S. L. (2015). Are We Spending Too Many Years in School? Causal Evidence of the Impact of Shortening Secondary School Duration. *German Economic Review*, **16** (1), 65–86.

Büttner, T. and Rässler, S. (2008). Multiple imputation of right-censored wages in the German IAB Employment Sample considering heteroscedasticity. *IAB discussion paper 44/2008*.

Caju, P., Lamo, A., Poelhekke, S., Kátay, G. and Nicolitsas, D. (2010). Inter-industry wage differentials in EU countries: What do cross-country time varying data add to the picture. *Journal of the European Economic Association*, **8** (2-3), 478–486.

Chapman, B. and Sinning, M. (2014). Student loan reforms for German higher education: financing tuition fees. *Education Economics*, **22** (6), 569–588.

Chi, W. and Li, B. (2008). Glass ceiling or sticky floor? Examining the gender earnings differential across the earnings distribution in urban China, 1987-2004. *Journal of Comparative Economics*, **36** (2), 243–263.

Chzhen, Y. and Mumford, K. (2011). Gender gaps across the earnings distribution for full-time employees in Britain: Allowing for sample selection. *Labour Economics*, **18** (6), 837–844.

—, — and Nicodemo, C. (2012). The Gender Pay Gap in the Australian Private Sector: Is Selection Relevant across the Wage Distribution? *IZA Discussion Paper 6558*.

Dickens, W. and Katz, L. F. (1986). Interindustry wage differences and industry characteristics. *NBER Working Paper No. 2014*.

Ding, W. and Lehrer, S. (2011). Experimental estimates of the impacts of class size on test scores: robustness and heterogeneity. *Education Economics*, **19** (3), 229–252.

Ehrenberg, R. G. and Webber, D. A. (2010). Do expenditures other than instructional expenditures affect graduation and persistence rates in American higher education? *Economics of Education Review*, **29** (6), 947–958.

Elder, T. E., Goddeeris, J. H. and Haider, S. J. (2010). Unexplained gaps and Oaxaca-Blinder decompositions. *Labour Economics*, **17** (1), 284–290.

Federal Statistical Office Germany (ed.) (2003). *German Classification of Economic Activities, Edition 1993 (WZ 1993)*. Wiesbaden.

Firpo, S., Fortin, N. and Lemieux, T. (2007). Decomposing Wage Distributions using Recentered Influence Function Regressions. *mimeo*.

—, — and — (2009). Unconditional Quantile Regressions. *Econometrica*, **77** (3), 953–973.

—, — and — (2011). Decomposition Methods in Economics. In O. Ashenfelter and D. Card (eds.), *Handbook of Labor Economics*, vol. 4, Part A, Elsevier, pp. 1–102.

Fischer, G., Janik, F., Müller, D. and Schmucker, A. (2009). The IAB Establishment Panel – things users should know. *Schmollers Jahrbuch*, **129** (1), 133–148.

Franz, W. and Steiner, V. (2000). Wages in the East German Transition Process: Facts and Explanations. *German Economic Review*, **1** (3), 241–269.

Funke, M. and Rahn, J. (2002). How efficient is the East German economy? An exploration with microdata. *Economics of Transition*, **10** (1), 201–223.

Gardeazabal, J. and Ugidos, A. (2004). More on identification in detailed wage decompositions. *Review of Economics and Statistics*, **86** (4), 1034–1036.

Gelman, A. and Hill, J. (2006). *Data analysis using regression and multilevel/hierarchical models*. Cambridge University Press.

Genre, V., Kohn, K. and Momferatou, D. (2011). Understanding inter-industry wage structures in the euro area. *Applied Economics*, **43** (11), 1299–1313.

Gernandt, J. and Pfeiffer, F. (2008). Wage convergence and inequality after unification: (East) Germany in transition. *ZEW Discussion Paper 08-022*.

Gittleman, M. and Pierce, B. (2011). Inter-Industry Wage Differentials Job Content and Unobserved Ability. *Industrial and Labor Relations Review*, **64** (2), 356–374.

Görzig, B., Gornig, M. and Werwatz, A. (2005). Explaining Eastern Germany's wage gap: the impact of structural change. *Post-communist economies*, **17** (4), 449–464.

Hamermesh, D. S. (1980). Commentary. In J. J. Siegfried (ed.), *The Economics of Firm Size, Market Structure and Social Performance*, Washington, D.C.: Federal Trade Commission.

Hans-Böckler-Stiftung (ed.) (2015). *Statistisches Taschenbuch – Tarifpolitik*. Düsseldorf.

Heckman, J. J. (1979). Sample selection bias as a specification error. *Econometrica*, **47** (1), 153–161.

Heining, J., Klosterhuber, W. and Seth, S. (2014). An overview on the Linked Employer-Employee Data of the Institute for Employment Research (IAB). *Schmollers Jahrbuch*, **134** (1), 141–148.

—, Scholz, T. and Seth, S. (2013). Linked-Employer-Employee data from the IAB: LIAB cross-sectional model 2 1993-2010 (LIAB QM2 9310). *FDZ-Datenreport 02/2013 (en)*.

Heywood, J. S. and Parent, D. (2012). Performance Pay and the White-Black Wage Gap. *Journal of Labor Economics*, **30** (2), 249–290.

Hirsch, B. T. (2004). Reconsidering Union Wage Effects: Surveying New Evidence on an Old Topic. *Journal of Labor Research*, **25** (2), 233–266.

Horrace, W. C. and Oaxaca, R. L. (2001). Inter-Industry Wage Differentials and the Gender Wage Gap: An Identification Problem. *Industrial and Labor Relations Review*, **54** (3), 611–618.

Jacobebbinghaus, P. (2008). LIAB-Datenhandbuch, Version 3.0. *FDZ-Datenreport 03/2008 (de)*.

Jones, F. L. (1983). On Decomposing the Wage Gap: A Critical Comment on Blinder's Method. *Journal of Human Resources*, **18** (1), 126–130.

Kassenböhmer, S. C. and Sinning, M. G. (2014). Distributional changes in the gender wage gap. *ILRReview*, **67** (2), 335–361.

Kirbach, M. and Smolny, W. (2011). Wage differentials between East and West Germany: are they related to the location or to the people? *Applied Economics Letters*, **18** (9), 873–879.

Koenker, R. and Bassett, G. (1978). Regression Quantiles. *Econometrica*, **46** (1), 33–50.

Krashinsky, H. (2011). Urban agglomeration, wages and selection: Evidence from samples of siblings. *Labour Economics*, **18** (1), 79–92.

Lallemand, T., Plasman, R. and Rycx, F. (2007). The establishment-size wage premium: evidence from European countries. *Empirica*, **34** (5), 427–451.

Lehmer, F. and Möller, J. (2010). Interrelations between the urban wage premium and firm-size wage differentials: a microdata cohort analysis for Germany. *The Annals of Regional Science*, **45** (1), 31–53.

Lewis, H. G. (1986). *Union Relative Wage Effects: A Survey*. Chicago: University of Chicago Press.

Lewis, M. J. and Wheaton, W. C. (2002). Urban wages and labor market agglomeration. *Journal of Urban Economics*, **51** (3), 542–562.

Lindner, P. (2015). Factor decomposition of the wealth distribution in the euro area. *Empirica*, **42** (2), 291–322.

Ludsteck, J. (2014). The Impact of Segregation and Sorting on the Gender Wage Gap: Evidence from German Linked Longitudinal Employer-Employee Data. *Industrial and Labor Relations Review*, **67** (2), 362–394.

Machado, J. A. F. and Mata, J. (2005). Counterfactual decomposition of changes in wage distributions using quantile regressions. *Journal of Applied Econometrics*, **20** (4), 445–465.

Magnani, E. and Zhu, R. (2012). Gender wage differentials among rural-urban migrants in China. *Regional Science and Urban Economics*, **42** (5), 779–793.

Matysiak, A. and Steinmetz, S. (2008). Finding Their Way? Female Employment Patterns in West Germany, East Germany, and Poland. *European Sociological Review*, **24** (3), 331–345.

Mincer, J. (1974). *Schooling, Experience and Earnings*. New York: Columbia University Press for National Bureau of Economic Research.

Neuman, S. and Oaxaca, R. L. (2004). Wage decompositions with selectivity-corrected wage equations: A methodological note. *Journal of Economic Inequality*, **2** (1), 3–10.

Neumark, D. (1988). Employers' discriminatory behavior and the estimation of wage discrimination. *Journal of Human Resources*, **23** (3), 279–295.

Nicodemo, C. (2009). Gender Pay Gap and Quantile Regression in European Families. *IZA Discussion Paper 3978*.

Nopo, H., Daza, N. and Ramos, J. (2011). Gender Earnings Gaps in the World. World Development Report 2012, Gender Equality and Development, Background Paper.

Oaxaca, R. (1973). Male-Female Wage Differentials in Urban Labor Markets. *International Economic Review*, **14** (3), 693–709.

Oaxaca, R. L. and Ransom, M. R. (1999). Identification in detailed wage decompositions. *Review of Economics and Statistics*, **81** (1), 154–157.

Ochsner, C. and Weber, M. (2014). Die Kleinteiligkeit der ostdeutschen Wirtschaft – dynamisch betrachtet. *ifo Dresden berichtet*, **21** (5), 22–33.

Rosenfeld, R. A., Trappe, H. and Gornick, J. C. (2004). Gender and Work in Germany: Before and After Reunification. *Annual Review of Sociology*, **30**, 103–124.

Schnitzlein, D. D. (2015). A New Look at Intergenerational Mobility in Germany Compared to the U.S. *Review of Income and Wealth*, (forthcoming).

Shapiro, C. and Stiglitz, J. E. (1984). Equilibrium unemployment as a worker discipline device. *The American Economic Review*, **74** (3), 433–444.

Smolny, W. (2009). Wage adjustment, competitiveness and unemployment – East Germany after unification. *Jahrbücher für Nationalökonomie und Statistik*, **229** (2–3), 130–145.

Steiner, V. and Wagner, K. (1997). East West German wage convergence – How far have we got? *ZEW Discussion Papers 97-25*.

Thaler, R. H. (1989). Anomalies – Interindustry Wage Differentials. *Journal of Economic Perspectives*, **3** (2), 181–193.

Troske, K. R. (1999). Evidence on the employer size-wage premium from worker-establishment matched data. *Review of Economics and Statistics*, **81** (1), 15–26.

Volkswirtschaftliche Gesamtrechnungen der Länder (VGRdL) (ed.) (2014a). *Arbeitnehmerentgelt in den kreisfreien Städten und Landkreisen der Bundesrepublik Deutschland 2000 bis 2012*. Reihe 2, Band 2, Stuttgart.

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Volkswirtschaftliche Gesamtrechnungen der Länder (VGRdL) (ed.) (2015a). *Arbeitnehmerentgelt, Bruttolöhne und -gehälter in den Ländern der Bundesrepublik Deutschland 2000 bis 2014*. Reihe 1, Band 2, Stuttgart.

Volkswirtschaftliche Gesamtrechnungen der Länder (VGRdL) (ed.) (2015b). *Bruttoinlandsprodukt, Bruttowertschöpfung in den Ländern der Bundesrepublik Deutschland 2000 bis 2014*. Reihe 1, Band 1, Stuttgart.

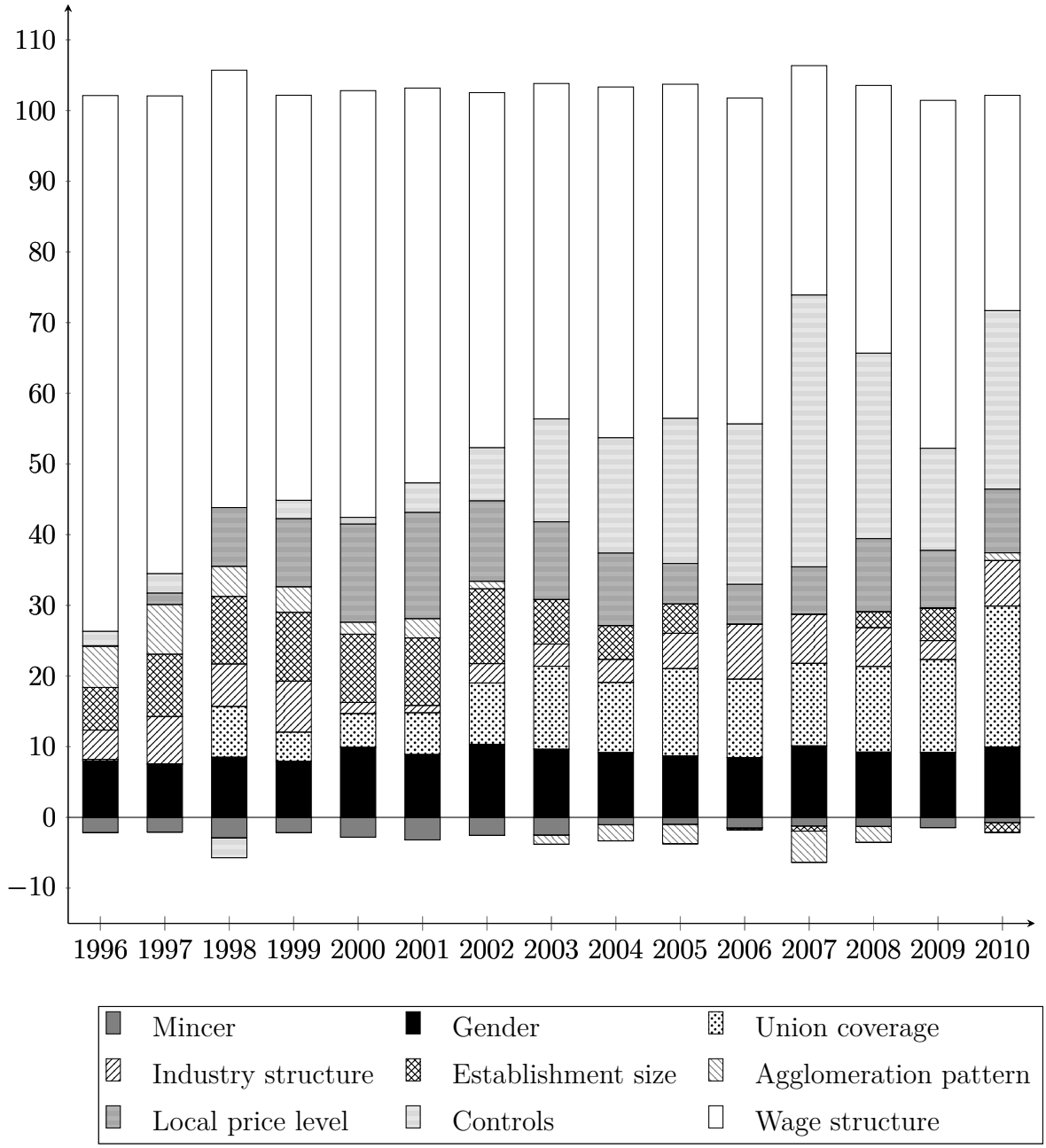
Weichselbaumer, D. and Winter-Ebmer, R. (2005). A meta-analysis of the international gender wage gap. *Journal of Economic Surveys*, **19** (3), 479–511.

Yellen, J. L. (1984). Efficiency wage models of unemployment. *The American Economic Review*, **74** (2), 200–205.

Yun, M.-S. (2005). A Simple Solution to the Indentification Problem in Detailed Wage Decompositions. *Economic Inquiry*, **43** (4), 766–772.

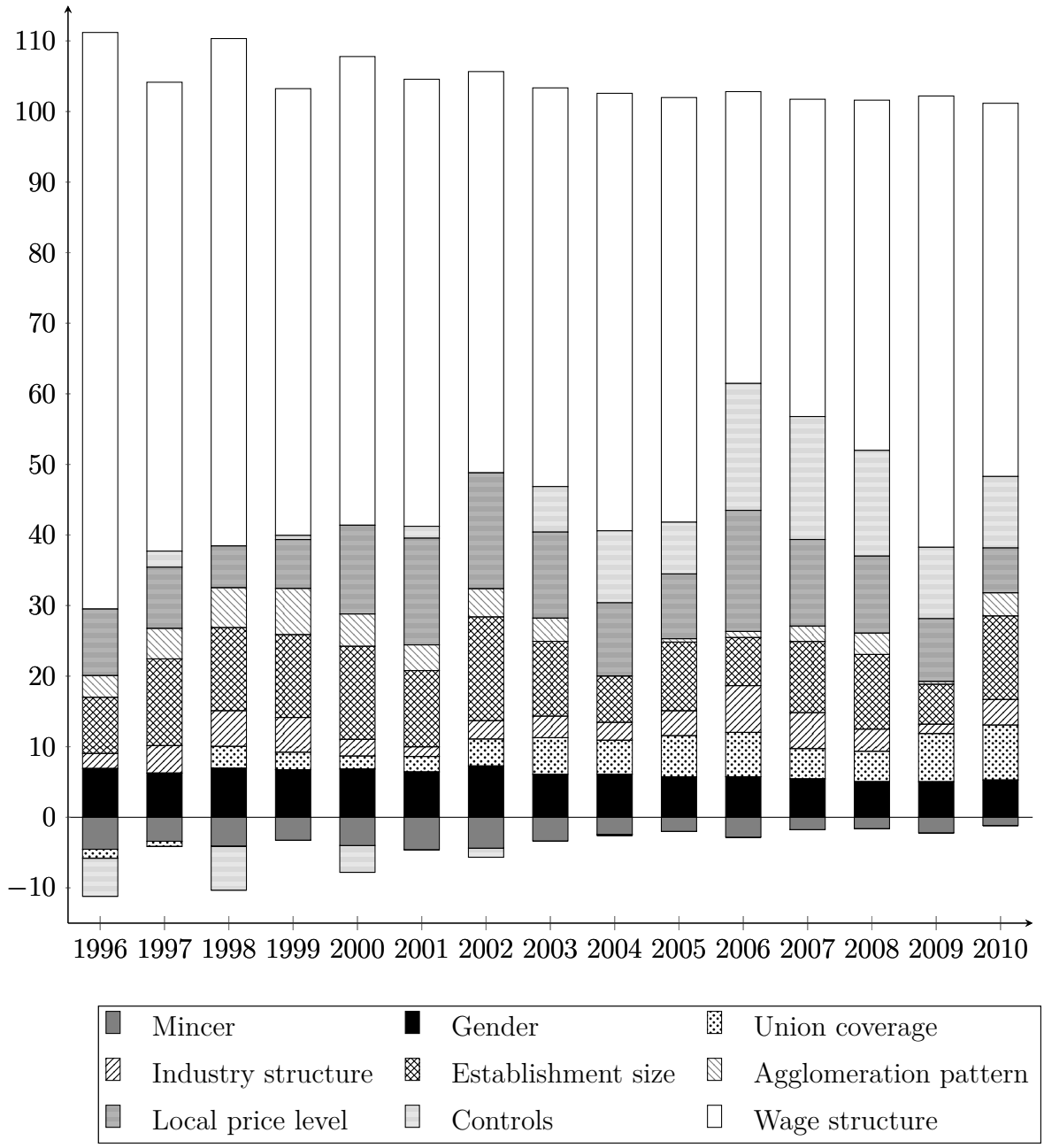
A. Appendix

Figure 4: Decomposition results: Share of the East-West wage gap at the 10%-quantile explained by differences in average characteristics



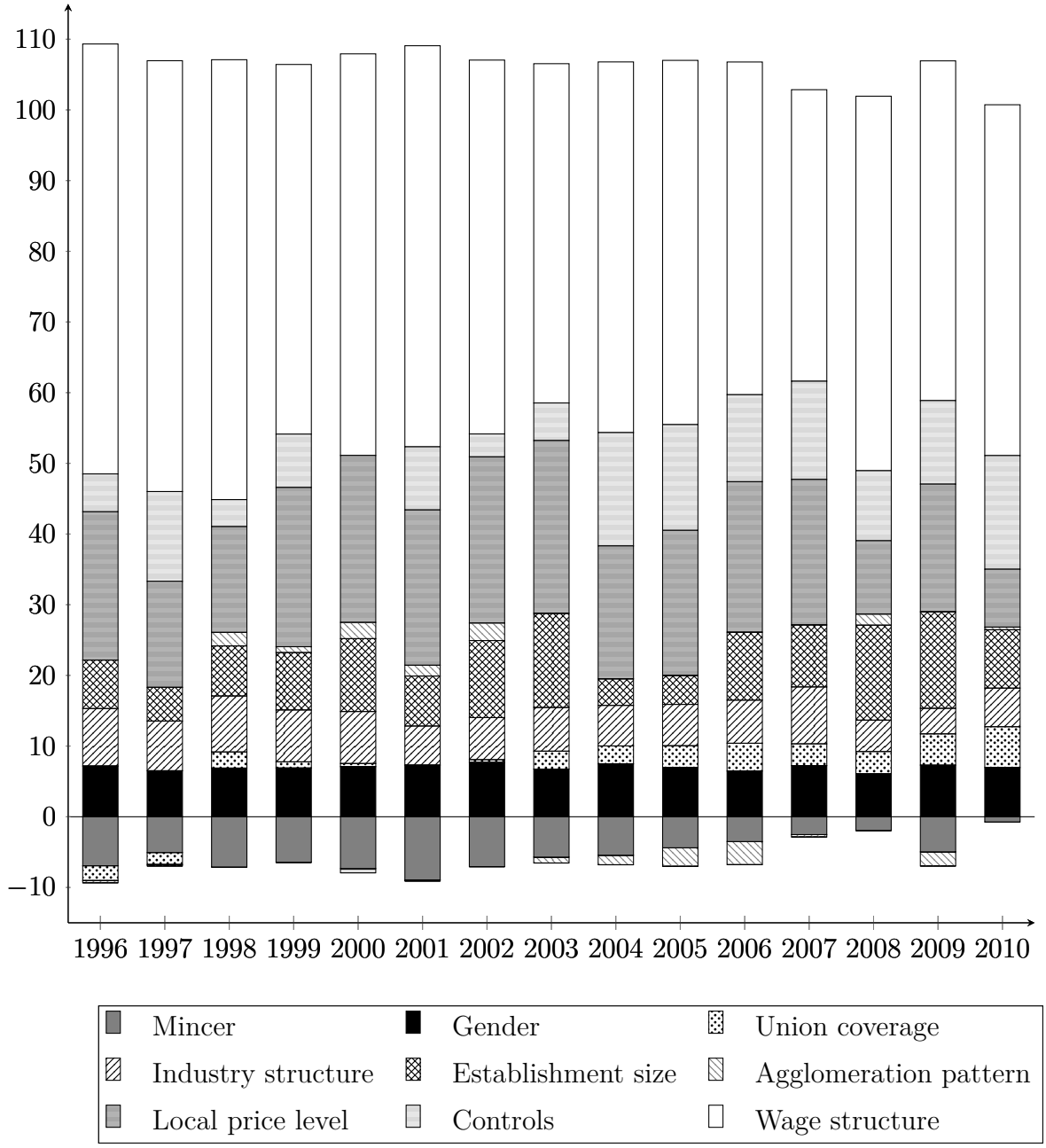
Reading example: Differences in the share of female employees between East and West Germany explain about 10% of the observed East-West wage gap in 2010.
Source: LIAB QM2 9310.

Figure 5: Decomposition results: Share of the East-West wage gap at the 30%-quantile explained by differences in average characteristics



Reading example: Differences in the share of female employees between East and West Germany explain about 5% of the observed East-West wage gap in 2010.
Source: LIAB QM2 9310.

Figure 6: Decomposition results: Share of the East-West wage gap at the 70%-quantile explained by differences in average characteristics



Reading example: Differences in the share of female employees between East and West Germany explain about 7% of the observed East-West wage gap in 2010.
Source: LIAB QM2 9310.

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