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East Germany's Wage Gap: A non-parametric decomposition based on establishment characteristics

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East Germany's Wage Gap: A non-parametric decomposition based on establishment characteristics¹

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Abstract:

East German wages have been below the West German wage level since unification. Moreover, the East-West wage gap implied by the contractual wages specified in collective wage agreements is drifting ever further apart from the wage gap in terms of effective wages. This paper looks at the role of establishment-specific factors — such as sectoral affiliation and size of the labour force — in this process. A non-parametric decomposition that has played a prominent role in the gender wage-gap literature is applied to breakdown the East-West wage gap into its constituent components. Using establishment data from the German employment statistics, the paper demonstrates that the divergence between wage agreements and effective wages is probably not a consequence of a massive escape from collective wage agreements, or the intense use of opt-out clauses in such agreements in East Germany. Rather, the shift of East Germany's economic structure towards lower-paying types of companies has caused the lagging behind in the adjustment of wages.

Keywords: Regional Wage Gap, Decomposition, Nonparametric Regression

JEL Classification: J31, L16, C14, C31

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1 Focus

In the economic policy debate concerning East Germany's economic catching-up process, wage differences between the old and new Federal States of Germany are very much at the forefront. Information on differences in wage agreements between trade unions and employers' organisations in East and West Germany are published regularly by the wage agreement database (HBS, 2004). From these, National Accounts calculations for the Federal States (VGRL, 2004) on employees' effective income differ substantially with regard to the findings on wage adjustment (cf. Table 1).

Table 1: Relative Wage Levels in East Germany according to Wage Agreements and Effective Outcome 1992 - 2002

Year	Relative wage levels in East Germany according to			
	Wage agreements ¹	Effective wage levels ²	Wage agreements ¹	Effective wage levels ²
	Average wage levels in East Germany			
	% of West Germany		Changes on previous year	
1992	73,0	67,7		
1993	80,0	74,2	7,0	6,5
1994	84,0	77,2	4,0	2,9
1995	86,0	79,1	2,0	1,9
1996	89,0	79,5	3,0	0,5
1997	90,0	79,8	1,0	0,2
1998	91,0	80,1	1,0	0,4
1999	91,5	80,9	0,5	0,7
2000	91,9	81,3	0,4	0,4
2001	92,3	81,2	0,4	-0,1
2002	92,8	81,2	0,5	-0,1

¹Wage Agreements Database of the Hans-Böckler Foundation. -
² National Accounts for German Federal States.

Following unification, the convergence process in terms of wage levels initially showed great dynamism. Both, the wage agreement data base and federal states national accounts statistics on effective wage levels show that this developed at very similar speed until 1995, i.e., wage agreements and effective wage adjustment progressed more or less in tandem. This development, however, changed dramatically during the second half of the 1990s. In terms of wage agreements, the speed of wage adjustment has been described as being much higher since 1996 than can be calculated from effective wage levels found in the national accounts statistics. For 2002, the wage agreement database shows an adjustment of East German wage agreements to just below 93% of Western German wage levels. According to the effective figures calculated from the national accounts statistics this figure stood at only 81% for the same period.

Deviations between wage agreement and effective wage level adjustments can indicate differences in the degree of wage drift (i.e., the extent to which remuneration exceeds wage agreements), the overall extent of adherence to collectively agreed wages, as well as the different usage of wage opt-out clauses by West and East German firms. However, the difference between wage agreement and effective wage level adjustment may also be due to structural differences. This relates, for one, to differences in the qualification structure of employees, and, for another, to differences in the type specific composition of firms in the East and West German economies.

This paper focuses in particular on the influence of differences in the type specific composition of firms, or establishments, on the drifting apart of wage agreements and effective wage levels between East and West Germany. It first outlines the present state of empirical research on the significance of firm-specific or establishment-specific factors for explaining wage differences. To quantify the influence of establishment-specific factors — such as type of industry and establishment size — on wage differences between the East and the West of Germany, a nonparametric decomposition approach is applied to establishment level data. This decomposition has until now been used in particular to explain gender wage differentials. Using a comprehensive data base derived from the employment statistics of the federal labour agency, it is possible to demonstrate that the drift of wage agreements and effective wage levels, as observed since 1996, can be explained by different changes in the type specific composition of firms in both parts of the country.

2 Wage Level Determinants

Descriptive empirical evidence on individual wage levels has led to the heuristic understanding that there are substantial differences in the remuneration for work performed. Within the model of perfect competition, this can be explained only with the heterogeneity of the labour input. If it were possible to adequately measure labour input in all its dimensions, then in principle it should be possible to explain all differences in remuneration through employees' marginal product. In this case, the divergence between East and West Germany, with respect to wage levels, would be entirely due to the different composition of the labour force within companies in both parts of the country with regard to employees' productivity. However, it is widely recognized that labour markets in both East- and West Germany are characterized by numerous regulations, as well as a system of collective bargaining on levels and structures of wages between trade unions and employers' associations. They are thus hardly compatible with the assumption of perfect competition.

In addition, any empirical test of the relevance of the theoretical model of perfect competition is necessarily restricted by the limited degree to which the heterogeneity of the labour input can be measured: in general, collecting adequate empirical information on employees' marginal products is extremely difficult.² The insufficient information concerning the heterogeneity of the labour input arises, on the one hand, because certain quality differences among employees, which influence productivity, cannot be detected in statistical surveys (Murphy and Topel, 1990). The company employing the workers, on the other hand, may very well be in the position to assess the quality of its employees. The company is therefore also often willing to pay a remuneration that corresponds to that quality — or to influence the quality delivered by the employees through the remuneration paid. This consideration is, for example, an important element in the efficiency wage approach (Akerlof, 1988). A further reason for the inadequate assessment of the heterogeneity of labour input is due to the fact that the actual heterogeneity is improperly homogenised by statistical classifications or by the use of proxy indicators.

Krueger and Summers (1988), however, throw serious doubt on the significance of unmeasured differences in the quality of labour to explain wage differences. By using improved micro-econometric methods and especially by applying improved and more comprehensive employer-employee data sets, it has become increasingly possible to establish the importance of unobservable differences between workers for explaining observed differences in their remuneration. Using a data set based on an employee survey in France, a recent study by Abowd, Kramarz, and Margolis (1999) concludes that wage differences for the most part can be explained by personal differences among employees. However, the applied methodical approach has been criticised by Winter-Ebmer and Zweimüller (1999). These authors have found that, for Switzerland, size-specific differences constitute only 50 percent of employees' individual and personal characteristics. Goux and Maurin (1999), although emphasizing personal factors in explaining inter-industrial wage differences in France, nevertheless suggest that wage differences discernible within an industry are due to factors such as capital intensity and company size. Burda (1991) presumes that a considerable part of unexplained wage differences in ordinary reduced-form wage equations are due to insufficient information, and cautions against excessive interpretation of the estimated inter-industrial wage differences based on these methods.

A large number of more recent empirical studies comes to the conclusion that actual differences in the level of wages cannot be satisfactorily explained with the heterogeneity of labour input, whether observable or not. The data sets used in these

² Occasionally a *deus ex machina* approach of measuring marginal products employs the relevant price information itself. However, such an approach not only relies on assuming perfect competition but is also ruled out in situations, where it is precisely this assumption that is to be examined.

analyses are very different in terms of both their scope and origin. Despite this, many analyses conclude that firm-specific differences can explain a significant fraction of observed wage differences (Krueger and Summer, 1988; Gibbons and Katz, 1991; Dickens and Katz, 1987). This leads to the theoretically inevitable conclusion that the model of perfect competition should be rejected in such cases (Blanchflower, Oswald and Sanfey, 1996).

Depending on the data set used and the method applied, the extent of the influence of firm-specific wage-level determinants is assessed differently. Especially the weight attributed to observable and non-observable firm-specific heterogeneity, respectively, varies with the method used; however, it also depends on the type and scope of the control variables employed, as well as on the respective region studied. A recent study based on an employer-employee data set for the state of Washington has found that approximately 50 percent of the observable wage differences can be explained by firm-specific factors (Abowd and Kramarz, 2000).

Industry and firm size are frequently singled-out as the most important firm-specific determinants on the level of individual wages - even in studies that employ a multitude of control variables. This has been also established — although not in every case — for East and West Germany (Bellmann and Kohaut, 1999).

Numerous theoretical explanations exist for the influence of a company's **sectoral affiliation** on employees' wages. On the one hand, there are institutional conditions on the input side, such as trade union power or the existence of a works council (Hübler and Jirjan, 2004). On the other hand, product market forces (Blanchflower, Machin 1996; Jirjahn and Klodt, 1999), especially competition conditions (Nickell, Vainiomaki and Wadhvani, 1994) are being emphasised.

Increased attention is also being paid to the closely connected question of implicit employee-employer rent-sharing (Blanchflower, Oswald and Sanfey, 1996; Hildreth and Oswald, 1997). Fakfakh and FitzRoy (2002) have, based on a data set for France with numerous control variables, been able to demonstrate such an effect. Margolis and Salvanes (2001) conclude that, for France, the strong link demonstrated in the raw data between profits and wages cannot be ruled out by alternatives to the rent-sharing hypothesis. The latter has been explicitly confirmed by them with Norwegian data.

It seems certain that the industry-specific wage differences remain remarkably persistent over time and that structures are remarkably similar across countries (Krueger and Summers, 1988). This is also true for the comparison of wage structures in France and Washington State (Abowd and Kramarz, 2000). While distinct differences have been noted with regard to regulated industries in France, recent studies (Grundig and Pohl, 2003) on the new Eastern European market

economies have found remarkably similar inter-industry wage structures in these countries.

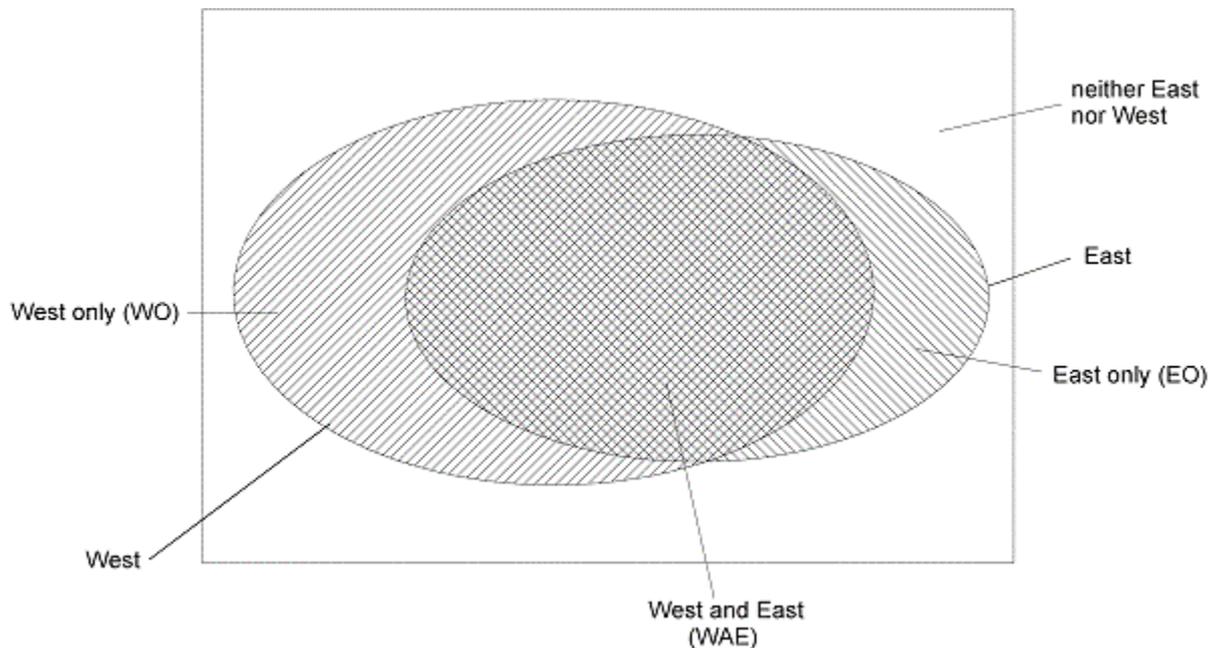
Similarly, the influence of **firm size** on wage levels seems very stable in an international comparison, and robust in the face of a number of other additional explanatory variables of conventional wage equations. In fact, the correlation seems to have become stronger (Gerlach and Hübler, 1995). Explanations for the influence of firm size on wage differences include, among others, implicit employee-employer rent-sharing, the complementarity of factor inputs, as well as monitoring costs, which both vary with firm size (Troske, 1999).

Brown and Medoff (1989) conclude that employees in larger companies exhibit a different quality (both measured and unmeasured) from those in smaller companies. Based on their research, however, only about 50 percent of observed wage differences are due to this personal influence. Further explanations are possibly monopsonistic demand conditions (Green, Machin and Manning, 1996). Idson and Oi (1999) argue that higher wages in larger companies are due to technological factors, employee preferences, and working conditions. In a recent longitudinal analysis, based on an employer-employee data set for France, Abowd and Kramarz (2000) conclude that 70 percent of the size-specific wage differences between companies in the raw data are the result of firm-specific factors.

Even if differences remain in the assessment of whether these relations are causal, research to date does seem to confirm that firm-specific factors play a considerable role in explaining differences in wage levels, and that these can, to a large extent, explain both industry-specific and firm size-specific wage differences. Thus, for a comparison of economic structures in the East and West of Germany, establishments have been standardised by differentiating between the industry to which they belong and the size of their work force.

3 Methodology

Starting point of our empirical analysis is the simple „raw“ difference between the average wage level in the West, $E[Y | West]$, and the average wage level in the East, $E[Y | East]$. This simple average wage difference $E[Y | West] - E[Y | East]$ is the focus of the public debate on this issue. It is computed as the difference of the average wage paid by all establishments found in the West and the average wage paid by all establishments found in the East. It is, however, only a very crude measure of the relative wage setting in both parts of the country. In particular, it is not the same as the average East-West wage differential between comparable enterprises. This is visualized in the Venn diagram of Figure 1.



Graph: Venn diagram of the sets of all possible and all existing types of establishments.

This diagram shows the set of all conceivable types of enterprises as a rectangular box. Some of the theoretically conceivable establishment types are neither found in the East nor the West (“neither East nor West”). Certain kinds of establishments, however, are only observed in the West (“West Only”) and, therefore, their wages are included in the Western average $E[Y|West]$ only. Similarly, certain types of establishments (and the associated wages) are found in the East only (“East Only”). Both “exclusive” groups of establishments have an influence on the average wage in their own particular region only and contribute in this way to the difference $E[Y|West] - E[Y|East]$.

Conversely, the intersection “East and West” contains all establishment types found both in the East and in the West. These constitute, according to the particular classification of enterprises chosen, the set of comparable establishments. The East-West wage differential between the members of this set is therefore but one component of the “raw” difference $E[Y|West] - E[Y|East]$. Establishments belonging to the intersection of Eastern and Western establishment types do not only influence the difference $E[Y|West] - E[Y|East]$ because observably identical establishments pay different wages in the West than in the East. They influence $E[Y|West] - E[Y|East]$ in another way: the distribution of characteristics among the members of this set is potentially different in both parts of the country. That is, while large establishments in manufacturing may be found both in the East and in the West, their share among all enterprises in their region may be much higher in the West than in the East.

The informal discussion of the previous paragraph is made precise by the following decomposition proposed by Nopo (2002), who – building on the seminal work of Blinder (1973) and Oxaca (1973) – has shown that the difference $E[Y | West] - E[Y | East]$ can be broken down into four additive components³:

$$E[Y | West] - E[Y | East] = \Delta_{West} + \Delta_{East} + \Delta_{Dist} + \Delta_{Reg}$$

Each of these components is closely connected to one of the shaded areas in Figure 1.

Now let $g^W(x)$ and $g^E(x)$ denote the average wage in the West and East, respectively, for establishment type x and let $f^W(x)$ and $f^E(x)$ denote the corresponding fractions of establishments of type x in the West and East, respectively. Using this notation, the unconditional average wage in each region can be written as a weighted sum of the type-specific averages:

$$E[Y | East] = \sum_{x \in EO \cup WAE} g^E(x) f^E(x)$$

and

$$E[Y | West] = \sum_{x \in WO \cup WAE} g^W(x) f^W(x)$$

The four components comprising the difference between $E[Y | West]$ and $E[Y | East]$ can now be shown to have the following precise form and interpretation:

The first component, Δ_{West} , is the component specific to the West and corresponds to subset WO of Figure 1. It is the part of the simple West-East average wage differential that can be attributed to those types of establishments that can be found exclusively in the West. Δ_{West} is formally defined as the difference between the average wage of the kinds of establishments found in the West only, and the average wage of those Western establishments, whose type is also observed in the East, weighted by the fraction of Western establishments with no match in the East, $P^W(WO)$:

³ Nopo (2002) discusses how this decomposition and the estimation of its components are tied to the literature on estimating (causal) treatment effects from nonexperimental data, in particular by using statistical matching. See also the related decomposition of the selection bias in Heckman, Ichimura, Smith and Todd (1996).

$$\Delta_{West} = \left\{ \sum_{x \in WO} g^W(x) \frac{f^W(x)}{P^W(WO)} - \sum_{x \in WAE} g^W(x) \frac{f^W(x)}{P^W(WAE)} \right\} P^W(WO)$$

The second component, Δ_{East} , is the component specific to the East and corresponds to subset EO of Figure 1. It is the part of the simple West-East average wage differential that can be attributed to those types of establishments that can be found exclusively in the East. Δ_{East} is formally defined as the difference between the average wage of Eastern establishments whose type can also be found in the West, and the average wage of those Eastern establishments, whose type is exclusively observed in the East, weighted by the fraction of Eastern establishments with no match in the West, $P^E(EO)$:

$$\Delta_{East} = \left\{ \sum_{x \in WAE} g^E(x) \frac{f^E(x)}{P^E(WAE)} - \sum_{x \in EO} g^E(x) \frac{f^E(x)}{P^E(EO)} \right\} P^E(EO)$$

The third component, Δ_{Dist} , corresponds to the subset WAE of Figure 1 and represents the part of the simple East-West wage differential, that can be attributed to unequal distributions of common establishment types in both parts of the country. That is, it arises from the fact that some establishment types are found both in the East and the West – but with unequal relative frequencies. Formally, Δ_{Dist} is the sum of the type-specific average wages in the West, weighted by the difference of the distributions with which these establishment types are observed in the West and East, respectively⁴:

$$\Delta_{Dist} = \sum_{x \in WAE} g^W(x) \left\{ \frac{f^W(x)}{P^W(WAE)} - \frac{f^E(x)}{P^E(WAE)} \right\}$$

The fourth component, Δ_{Reg} , also corresponds to subset WAE of Figure 1 and represents the part of the simple wage gap $E[Y|West] - E[Y|East]$, that can be attributed to the East-West differences in the wage of the establishments found in both parts of the country – i.e., to the “true” regional wage differential between observationally identical establishments. Δ_{Reg} is formally defined as the sum of the

⁴ Formally, the wage gap between the two parts of the country could be defined by reversing the order, i.e. by considering $E[Y|West] - E[Y|East]$. Reversing the order of the regions implies changes in the precise definitions of Δ_{Dist} and Δ_{Reg} . However, the particular order “West minus East” is suggested by the aim of the present paper: studying the adjustment of Eastern wages towards the reference level of Western wages.

type-specific East-West wage differentials, weighted by the fraction with which each type is found in the East:

$$\Delta_{\text{Reg}} = \sum_{x \in \text{WAE}} \left\{ g^E(x) - g^W(x) \right\} \frac{f^E(x)}{P^E(\text{WAE})}$$

Each of the formal definitions of the four components of $E[Y | \text{West}] - E[Y | \text{East}]$ involves the conditional expectation functions $g^W(x)$ and $g^E(x)$. These functions spell out how average wages in the West and East, respectively, vary with the establishment type x . Note that no particular functional form has been assumed for either $g^W(x)$ or $g^E(x)$. Instead, both regression functions are nonparametrically defined and estimated – the latter by computing average wages for each type of establishment (and each region) separately.

Alternatively, the regression functions $g^W(x)$ and $g^E(x)$ could be defined and estimated parametrically, for instance, by assuming that average wages vary linearly with establishment characteristics. That is, a more standard approach would impose that $g^W(x) = \mathbf{b}_W^T x$ and $g^E(x) = \mathbf{b}_E^T x$ and estimate the parameter vectors \mathbf{b}_W^T and \mathbf{b}_E^T by Least Squares. While estimating and interpreting this specification is straightforward, its desirable statistical properties hinge on the validity of the linearity assumption. The approach followed in this paper, to specify $g^W(x)$ and $g^E(x)$ nonparametrically, does not require to impose strong *a priori* restrictions on the way average wages are allowed to vary with establishment characteristics. Moreover, the huge size of our sample (defined in the following section) ensures that the data-hungry nonparametric approach has sufficiently large samples to work with to compute the many establishment-type specific averages that form its estimates of $g^W(x)$ and $g^E(x)$.

The nonparametric decomposition defined above offers an additional advantage over the parametric approach as it explicitly includes the components of the raw difference in Western and Eastern wages due to establishment types found exclusively in the West or East, respectively. The corresponding parametric decomposition due to Blinder and Oaxaca, however, yields expressions for Δ_{Reg} and

Δ_{Dist} only.⁵ It ignores the components attributable to establishments outside the “common support” of establishment types found in both parts of the country.⁶

4 Data

The ability to differentiate between “structural” components of the wage differential on the one hand (i.e., Δ_{East} , Δ_{West} and Δ_{Dist}) and the mere regional wage component (Δ_{Reg}), on the other hand, depends largely on the extent with which differences between the East and West German populations of establishments can be measured.

Data sets containing representative and compatible information for East and West Germany regarding wage levels, industry and size of establishments is hard to find. Neither the available information from the database of collective wage agreements nor the information on effective earnings from the national accounts is broken down by sector and/or size. Other frequently cited sources for comparisons between East and West such as the Socio-Economic Panel (Burkhauser/Kreyenfeld/Wagner, 1997), the Mannheim Innovation Panel (Rammer, et. al., 2003) or the IAB-firm panel (Bellmann, 2002) differentiate between these criteria but are inappropriate for a nonparametric decomposition of the wage gap due to their rather small sample sizes.

Information on the wage level of their employees, their sectoral affiliation and the size of virtually all German establishments can be drawn from their mandatory regular notifications to the employment database of the Federal Agency for Employment (Bundesagentur für Arbeit/BA). This database includes all establishments with at least one employee making social security contributions. The database presently contains information about roughly 30 million employer-employee relationships and approximately 2.5 million establishments per year. The survey, thus, covers far more than 90 % of all establishments and, therefore, is nearly a total census. These data are one of the central sources for the labour accounts in the German national accounting system. For this study, employment data from this source have been aggregated to the establishment level. While this, in principle, could be done for any year, only the 1994 and 1998 data sets have been made available for this study.

⁵ In the parametric case, $D_{Reg} = (\mathbf{b}_W^T - \mathbf{b}_E^T) \bar{\mathbf{x}}_E$ and $D_{Dist} = \mathbf{b}_W^T (\bar{\mathbf{x}}_W - \bar{\mathbf{x}}_E)$ where $\bar{\mathbf{x}}$ denotes a vector of sample averages of establishment characteristics.

⁶ It does so by using its linear functional form assumption to extrapolate into areas of establishment types not found in the data.

Despite its census-like size and coverage, the database has some shortcomings that are mainly due to its administrative origin (Fritsch, König, Weißhuhn, 1992). Since only employment relationships in the realm of the (largely mandatory) social security system are covered, certain persons and establishments, like the self-employed, are not included in the data. Additionally, high wages are top-coded, using the upper limit for contributions to the social security system.⁷ However, top-coded wages seem to be much more a problem for the comparison of individual wages than for an analysis of establishment-level wages.⁸ For the present analysis, therefore, it is assumed that such restrictions are of minor importance, especially since the central results refer to the changes over time in the level and decomposition of the East-West wage gap, and it is fair to assume that the shortcomings of the dataset have not significantly changed in the period under study.

The wage level of each establishment is recorded as the average wage per day and employee.⁹ With respect to their industry, establishments are classified according to the sectoral code of the Federal Employment Agency following the Nace.Rev.3 structure in 54 category groups (see appendix 2). Regarding the size, the firms are — based on the number of employees — divided into 10 size classes. This exceeds slightly the classification, which is commonly applied in the statistics on manufacturing (see appendix 1). In the combination, there are 540 cells, which can be used for classification of establishments and their employees in East and West Germany.

5 Results

Combining the selected characteristics (industry type and establishment size) yields a total of 540 possible types of establishments. Of these, 460 establishment types actually exist in East Germany in 1994 while roughly 500 types exist in West Germany (see Table 2).

For both years, in East Germany the number of establishments belonging to a type, which does not exist in West Germany, is less than three. Reciprocally, in 1998 nearly 500 West German establishments belong to an industry-size combination,

⁷ As the wage levels between East- and West Germany differ, so do the upper levels for the social security contributions in the two parts of the country. Furthermore, the respective upper wage levels are dynamically adapted to the increase in wage levels in each part of the country.

⁸ For all establishments, Görzig (1998) found that the average share of top-coded employees in West Germany in 1989 to be only 2%. Therefore, in comparing average wage levels of establishments, minor changes in the share of top-coded wages cannot dramatically influence relative wage levels between establishments.

⁹ Since individual remuneration varies with the number of employment days, the average wage level of an establishment has been calculated with wages standardised as average wage per day.

which cannot be found in East Germany. The latter group mainly consists of large establishments with more than 5000 employees in the chemical industry and in vehicle construction. Approximately 4 % of all West German employees are employed in these exclusively West German types of establishments. However, the overwhelming majority of all employees and nearly all establishments belong to those types of establishments, which are present in both parts of Germany with at least one establishment.

The distribution of establishments and employees across the three cases (Types of establishments that exist “only in East Germany”, “only in West Germany” or “in both regions”) hardly shows any changes between 1994 and 1998. Based on this typification, there are no signs that an economy has developed in East Germany, characterised by establishment types, which do not at all exist in the reference region of West Germany. Moreover, the number of employees in those types of establishments, which can exclusively be found in West Germany, is rather small and has not changed much in the years considered. A development towards two completely different specialised regions apparently has not taken place after unification in Germany. Nevertheless, there are remarkable structural divergences between East and West Germany because the relative distribution of the comparable types of establishments is different.

Table 2: Number of Establishments and Employment Cases for different Types of Establishments in East and West Germany 1994 and 1998

Type of establishment	East Germany	West Germany	East Germany	West Germany	Type of establishment combinations
	Establishments		Employment cases		
	in 1000				
	1994				
Type exists					
only in West Germany	-	0,4	-	1170,1	43
only in East Germany	*1	-	5,4	-	1
in both regions	473,2	1700,1	6872,5	25264,3	460
	1998				
Type exists					
only in West Germany	-	0,5	-	937,5	46
only in East Germany	*1	-	15,3	-	2
in both regions	473,4	1746,7	6087,8	24550,7	458
¹ Less than 3 establishments.					
Sources: Federal Labour Office for Germany, Employment survey, Own calculations.					

The difference between the types of establishments, which are exclusively found in East or West Germany, respectively, as well as the relative distribution of the types of establishments in both parts of the country have been quantified as structural components in the explanation of the regional wage differences (see Table 3).

In the base year 1994 the raw difference in the wage levels between East and West Germany amounts to 37,50 DM per employee and day. This is equivalent to a wage gap in East Germany of 27 %. Exclusively East German types of establishments hardly contribute anything to explain this wage difference. Conversely, the types of establishments exclusively present in West Germany considerably contribute to the wage difference between East and West Germany. This group of large industrial establishments pays wages far above the East and West German average. Without the influence of these types of establishments, the East German wage gap would be smaller by an amount of 1,90 DM per employee and day - which equals 5 % of the raw difference. Additionally, in 1994 there was a slightly higher fraction of establishments in East Germany paying wages below the national average. This component also contributes 1,90 DM to the raw difference between the average wage levels of East and West Germany.

Table 3: Decomposition of the Raw Wage Differences between West and East Germany 1994 and 1998

year	Raw wage difference	Structural components			Regional wage level component
	West Germany minus East Germany	Type exists only in		Distribution of establishment types	
		East Germany	West Germany		
Δ	Δ_{East}	Δ_{West}	Δ_{Dist}	Δ_{Reg}	
	Difference in average earnings per day in DM				
1994	37,5	0,0	1,9	1,9	33,7
1998	35,6	0,1	1,8	5,5	28,3
	Changes on 1994				
1998	-1,9	0,1	-0,1	3,6	-5,4
Sources: Federal Labour Office for Germany, Employment survey, Own calculations.					

The decomposition in Table 3 also shows that the wage difference between East and West Germany in 1994 is only to a small extent caused by structural differences between the two parts of Germany with regard to their industry and size specific distribution of establishment types. Rather, nearly 90 % of the raw difference in the wage levels between East and West Germany result from the fact that comparable establishments (i.e., those of the same observable type) in East Germany pay less than their West German counterparts. That is, the genuinely regional component is the dominant part of the East-West wage difference.

Four years later (1998), the raw difference between the average wage levels of East and West Germany has slightly decreased to 35,60 DM per employee and day. The influence of the truly regional component of the wage gap is still dominant,

accounting for approximately 80 % of the raw difference between East and West German average wage levels. However, its influence has considerably declined for the benefit of the structural components.

This increase in the contribution of the structural components is almost exclusively due to the part stemming from the different distributions of common establishment types in both parts of the country. Compared to West Germany, the East German economic structure has evolved towards those types of establishments, which pay wages below the regional average. Compared to 1994, the share of the distributional component in the raw difference of the wage levels between East and West Germany has nearly tripled in 1998. The miniscule influence of exclusively East German types of establishments on the wage gap has almost remained unchanged. This is also true for the contribution of large industrial establishments with high wage levels, which only exist in West Germany.

The increasing influence of the structural components as a whole on the East-West wage difference offers an explanation for the drifting apart of formal wage agreements and effective wage levels in the middle of the 1990s. In order to compare the empirical results of Table 3 with the reference figures of Table 1, the former were expressed in the form of the index wage level in East Germany as a percentage of the respective West German values (see Table 4).

Table 4: Wage Level in East Germany in Relation to West Germany, Different Sources, 1994 and 1998

Year	Raw wage relation according to			Wage relation based on	
	Wage agreements ¹	Effective wage levels ²	Employment survey ³	Regional wage differences	Structural wage differences ⁴
	Relative wage level in East Germany as % of West Germany				
1994	84,0	77,1	72,4	75,2	97,2
1998	91,0	80,1	75,5	80,6	95,0
	Changes on 1994				
1998	7,0	3,0	3,1	5,4	-2,2
¹ Wage Agreements Database of the Hans-Böckler Foundation. - ² National Accounts for German Federal States. - ³ Federal Labour Office. - ⁴ Including the components for establishments that exist exclusively either in East or in West Germany.					

The extent of the wage adjustment in East Germany between 1994 and 1998 implied by our empirical results approximately equals that derived from the National

Accounts. The change of the wage relation implied by the genuinely regional effect (5,4 percentage points), however, is much closer to the change in relative wages according to formal wage agreements (7 percentage points). The most important reason why the rapid adjustment process in terms of wage agreements was not reproduced by the adjustment in effective earnings apparently lies in the different developments of the industry- and size-specific establishment structures that occurred in the two parts of the country. Indeed, the diverging establishment structures in the Eastern and Western parts of Germany have caused the wage differential to increase by more than 2 percentage points between 1994 and 1998.

6 Conclusions

Nonparametrically decomposing the East-West wage differential into structural components and a genuinely regional component yields several insights into the process by which East German wages adjust to the West German level. Based on the purely regional component alone, the speed of the adjustment between 1994 and 1998 hardly differs from that implied by formal wage agreements. The wages paid by comparable establishments (with regard to industry and size) appear to adhere to collective wage agreements in both East and West Germany. The strong divergence in the middle of the 1990s between the speed of East-West wage adjustment implied by collective wage agreements and that implied by effective wages (as measured in the National Account Statistics) therefore neither seems to be the result of a massive escape of East German establishments from collective wage agreements nor the result of their more extensive use of opt-out clauses.

The analysis shows that the slower adjustment speed of effective wages can be attributed to the different shifts occurring in the establishment structures in West and East Germany. The adjustment of East German wages to the West German level according to collective wage agreements was at least in part offset by the concurring changes in the sector- and size-specific establishment structures. The East German economy obviously shifted towards establishment types paying wages below the national average.

Hence, while establishment structures in East and West Germany are largely comparable, the shares of certain high-wage and low-wage establishment types have started to diverge. In the process, the new Federal States appear to have moved (in relative terms) towards being a low wage region – albeit a *structural* low wage region. However, this development has merely slowed down but not reversed the movement of East German wages towards the Western level.

Literature

- Akerlof, George (1984): "Gift Exchange and Efficiency-Wage Theory: Four Views", *American Economic Review* 74, 79 - 83.
- Abowd, John, Francis Kramarz and D. Margolis, 1999, "High wage workers and high wage firms", *Econometrica*, March, 67 (2), pp. 251-333.
- Abowd, John, and Francis Kramarz, 2000, "Inter-industry and Firm-size Wage Differentials: New Evidence from Linked Employer-Employee Data", Cornell University working paper.
- Bellmann, Lutz, 2002, "Das IAB-Betriebspanel", Konzeption und Anwendungsbereiche. In: *Allgemeines statistisches Archiv*, Bd. 86, H. 2. S.177-188.
- Bellmann, Lutz and Kohaut, Susanne, 1999, "Betriebliche Lohnbestimmung in ost- und Westdeutschen Betrieben - Eine Analyse mit Daten des IAB-Betriebspanels". In: Lutz Bellmann, Susanne Kohaut and Manfred Lahner (Hrsg.). *Zur Entwicklung von Lohn und Beschäftigung auf der Basis von Betriebs- und Unternehmensdaten*, Beiträge zur Arbeitsmarkt und Berufsforschung, Bd. 220, S. 9 -25.
- Blanchflower, David, Andrew Oswald and Peter Sanfey, 1996, "Wages, Profits and Rent-Sharing", *Quarterly Journal of Economics*, 111, pp. 227-251.
- Blanchflower, David and Stephen Machin, 1996, "Product Market Competition, Wages and Productivity: International Evidence from Establishment-Level Data, CEP Discussion papers.
- Blinder, Alan, 1973, "Wage Discrimination: Reduced Form and Structural Estimates", *The Journal of Human Resources*, VII (4), pp. 436-455.
- Brown, Charles and James Medoff, 1989, "The Employer Size-Wage Effect," *Journal of Political Economy*, 97, pp. 1027-1059.
- Burda, Michael, 1991, "Some New Insights on the Interindustry Wage Structure from the German Socioeconomic Panel", *DIW Diskussionspapiere*, 30.
- Burkhauser, Richard, Michaela Kreyenfeld and Gert G. Wagner, 1997, "The German-Socio-Economic Panel: A Representative Sample of Reunited Germany and its Parts". In: *Vierteljahrshefte zur Wirtschaftsforschung*, 66(1), Berlin: Duncker & Humblot, 1997, pp. 7-16.
- Dickens, William, Lawrence Katz, 1987, "Inter Industry Wage Differences and Theories of Wage Determination", NBER Working Paper No. w2271.
- Fakfakh, Fathi and Felix FitzRoy, 2002, "Basic wages and firm characteristics: Rent-sharing in French Manufacturing", University of St Andrews, Discussion paper 203.
- Fritsch, Michael, Andreas König, Gernot Weißhuhn, 1992, *Probleme und Vorgehensweisen bei der Bereinigung der in eine Betriebsdatei transformierten Beschäftigtenstatistik*, Berlin (mimeo).
- Gerlach, Knut, und Olaf Hübler, 1995, "Betriebsgröße und Einkommen. Erklärungen, Entwicklungstendenzen und Mobilitätseinflüsse", in: Viktor Steiner, Lutz Bellmann,

- (Hrg.), *Mikroökonomik des Arbeitsmarktes, Beiträge zur Arbeitsmarkt und Berufsforschung*, Bd. 192, S. 225-264.
- Gibbons, Robert and Lawrence Katz, 1992, "Does Unmeasured Ability Explain Inter-Industry Wage Differentials?", *Review of Economic Studies*, 59, pp. 515-535.
- Görzig, Bernd, Wolfgang Scheremet and Frank Stille, 1998, *Zum Einfluss betrieblicher und sektoraler Differenzierung der Arbeitskosten und sonstiger Regelungen auf die Beschäftigung im Strukturwandel*, DIW Beiträge zur Strukturforschung, Heft 176, Berlin.
- Goux, Dominique and Eric Maurin, 1999, "Persistence of Inter-Industry Wage Differentials: A Reexamination on Matched Worker-Firm Panel Data," *Journal of Labor Economics*, 17, pp. 492-533.
- Green, Francis, Stephen Machin, Alan Manning, 1996, "The Employer Size-Wage Effect: Can Dynamic Monopsony provide an Explanation?", *Oxford Economic Papers* 48, 433-455.
- Grundig, Beate, and Carsten Pohl, 2003, "Interindustrielle Lohndifferenzierung in Zentraleuropa", in: ifo-Schnelldienst, Heft 24.
- HBS, 2004, Hans Böckler Stiftung, Tarifarchiv, Bereich Tarifdaten, Tarifniveau Ost/West, Düsseldorf.
- Heckman, J. J., Ichimura, H., Smith, J., & Todd, P. (1996) "Sources of Selection Bias in Evaluating Social Programs: An Interpretation of Conventional Measures and Evidence on the Effectiveness of Matching as a Program Evaluation Method", *Proceedings of the National Academy of Sciences of the United States of America*, 93, 23, 13416-13420.
- Hildreth, Andrew and Andrew Oswald, 1997, "Rent Sharing and Wages: Evidence from Company and Establishment Panels", *Journal of Labour Economics*, 15, pp. 318-37.
- Hübler, Olaf and Uwe Jirjahn, 2004, "Works Councils and Collective Bargaining in Germany: The Impact on Productivity and Wages", *Scottish Journal of Political Economy*, 50 (4), 2003, 471-491.
- Idson, Todd and Walter Oi, 1999, "Workers Are More Productive in Large Firms," *AEA, Papers and Proceedings*, Vol. 89, No. 2, pp. 104-108.
- Jirjahn, Uwe and Thomas Klodt, 1999, "Lohnhöhe, industrielle Beziehungen und Produktmärkte". In: L. Bellmann, S. Kohaut & M. Lahner (Hrsg.). *Zur Entwicklung von Lohn und Beschäftigung auf der Basis von Betriebs- und Unternehmensdateien*, Beiträge zur Arbeitsmarkt- und Berufsforschung Bd. 220. S. 27-54.
- Katz, Lawrence and Lawrence Summers, 1989, "Industry Rents: evidence and implications", *Brookings Papers on Economic Activity*, (Microeconomics), pp. 209-275.
- Krueger, Alan and Lawrence Summers, 1988, "Efficiency Wages and the Inter-Industry Wage Structure," *Econometrica*, 56, pp. 259-293.
- Margolis, David and Kjell Salvanes, 2001, "Do Firms Really Share Rents with their Workers", IZA DP No.330, Bonn.

- Murphy, Kevin and Topel, Robert, 1990, "Efficiency wages reconsidered: theory and evidence", in Weiss Y. and Fishelson G. eds., *Advances in the Theory and Measurement of Unemployment*, London: Macmillan.
- Nickell, S., J. Vainiomaki and S. Waidhwani, 1994, "Wages and Product Market Power", *Economica*, 61: 457-73.
- Nopo, Hugo 2002, "Matching as a Tool to Decompose Wage Gaps", mimeo, NorthWestern University.
- Oaxaca, R., 1973, "Male-Female Wage Differentials in Urban Labor Markets," *International Economic Review*, 14 (3), pp. 693-709.
- Rammer, Christian, Günther Ebling, Sandra Gottschalk, Norbert Janz, Bettina Peters and Tobias Schmidt, 2003, "Innovationsverhalten der deutschen Wirtschaft", *Indikatorenbericht zur Innovationserhebung 2002*, Zentrum für Europäische Wirtschaftsforschung, Mannheim.
- Troske, Kenneth R, 1999, "Evidence on the Employer Size-Wage Premium from Worker-Establishment Matched Data", *The Review of Economics and Statistics*, 81: 15-26.
- VGRL, 2004, *Volkswirtschaftliche Gesamtrechnung der Länder: Bruttolöhne und Gehälter*, Statistisches Landesamt Berlin, Abt. IV, Berlin.
- Winter-Ebmer, Rudolf and Josef Zweimüller, 1999, "Firm Size Wage Differentials in Switzerland: Evidence from Job Changers", *American Economic Review, Papers and Proceedings*, Vol. 89, No. 2, pp. 89-93.

Appendix

Appendix 1: East German wage gap in industries

No.	Industry	BA Classification	Average wage per day 1998	
			DM	% of West Germany
1	Agriculture, forestry, fishing	00 - 03	85	80
2	Energy, water supply	04	161	79
3	Coal mining	05	158	87
4	Other mining	04 - 08	152	80
5	Chemical products	09, 10	137	70
6	Refining, coke	11	151	67
7	Plastics	12	104	69
8	Rubber products	13	107	66
9	Quarrying	14	120	72
10	Ceramics	15	105	73
11	Glas products	16	106	69
12	Iron and steel	17	140	78
13	Non ferrous metals	18	134	75
14	Foundries	19	123	73
15	Steel mills	20 - 22	102	67
16	Steel industry	23, 24	117	71
17	Machinery equipment	26, 27	130	71
18	Office and data processing equipment	33	127	64
19	Road vehicles	28, 29	110	61
20	Vessels	31	147	83
21	Aircrafts and spacecrafts	32	158	73
22	Electrical engineering	34	128	71
23	Precision and optical instruments	35, 36	107	70
24	Metal products	37	109	69
25	Furniture, toys	38, 39	81	64
26	Wood	40	103	71
27	Wood products	41, 42, 53	96	68
28	Pulp and paper	430	116	67
29	Paper products	431 - 433	107	71
30	Printing	44	119	72
31	Leather	45, 46	81	65
32	Textiles	47 - 51	83	62
33	Clothing	52	75	63
34	Food	54 - 56	82	68
35	Bevrages	57	138	83
36	Tobacco	58	152	79
37	Buildings and construction	59, 60	110	73
38	Auxiliary construction	25, 61	100	72
39	Wholesale trade	620, 621	114	73
40	Retail trade	622 - 625	86	76
41	Railways	63	135	86
42	Other transports	65 - 68	102	73
43	Post and telecommunication	64	133	107
44	Banking	690	159	87
45	Insurances	691	143	77
46	Hotels and restaurants	70, 71	74	83
47	Education	74 -77	121	77
48	Health	78	91	85
49	Cleaning, personal services	72, 73	63	77
50	Consulting	79	121	74
51	Other services	80 - 85	100	82
52	General government	91 - 94	136	95
53	Private households, NISPH	87 - 90	107	80
54	Others		109	75

Appendix 2: East German wage gap for establishment size classes

Size class	Number of employees	Average wage per day 1998	
		DM	% of West Germany
1	1	77	94
2	2 - 9	86	80
3	10 - 19	102	78
4	20 - 49	108	77
5	50 - 99	113	77
6	100 - 199	115	77
7	200 - 499	120	77
8	500 - 999	125	76
9	1000 - 4999	135	79
10	5000 and more	148	78

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