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The Agglomeration Differential Reconsidered*

An Investigation With German Micro Data 1984-1997

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Abstract

The paper analyzes the wage structure in Germany for different types of regions on the basis of panel micro data 1984-1997. Besides the spatial aspects we differentiate between two sectors of the economy (Manufacturing and Services), three skill groups and deciles of the wage distribution. After discussing alternative theoretical explanations for spatial wage differentials, we first present descriptive evidence by comparing the wage level in agglomerations and the rural periphery. According to our findings, an agglomeration differential does exist except for low-skilled service workers. A detailed econometric analysis based on a quantile regression approach corroborates this result. Observationally equivalent workers in agglomerations in general earn significantly more than their colleagues in rural areas. The agglomeration wage differential positively depends on the skill level. It tends to be higher in the manufacturing sector and to increase with the decile of the wage distribution. Our results indicate that a doubling of employment density leads to gross wage increase of 2.5 percent in the average.

Theme: Regional labour markets

Keywords: Spatial wage structure, agglomeration wage differential, quantile regressions, skill premium

JEL-Klassifikation:

J31, R12

1 Introduction

The famous contribution of Krueger, Summers (1988) has launched a renewed interest in the structure and development of wages in the last fifteen year or so. Different perspectives can be distinguished. In one branch of the literature the focus is on the flexibility of wage adjustment in face of supply and demand shocks. This flexibility plays a dominant role in the modern macroeconomic theory of unemployment.[1] In another branch, the wage structure is analyzed in their own right. As has been widely documented, wage differentials can partly be explained by qualification, experience and other personal attributes.[2] The characteristics of the firm like size, industry affiliation and market power are significant influences on wages as well.[3]

The *regional* dimension of wage determination has mainly been investigated in the context of the *wage curve* as a relation between the regional wage level and the unemployment rate (Blanchflower, Oswald 1990, 1994). Although the wage curve is an important concept for understanding the functioning of shock absorption in a system of regions, it neglects further aspects of the spatial wage structure. Despite of the surge of new regional economics, only few empirical studies deal with these –perhaps equally important – factors in recent years.[4]

In this paper the main focus is on a classical theme in regional economics, the agglomeration effect on wage formation. There are at least two reasons justifying a re-investigation. First, the access to micro panel data with regional information has considerably been improved in recent years. Since with micro data differences in individual characteristics can adequately be taken into account, interregional comparisons will be more reliable. Second, because of the large number of observations it is possible to obtain sufficient large cells sizes for individuals with roughly the same characteristics. For these cells different quantiles describing the wage distribution can be calculated. Hence we are able to analyze specific agglomeration effects in the lower and upper tail of the wage distribution.

The paper is organized as follows: In the next section we briefly discuss the theoretical background. Section 3 presents some descriptive evidence. In section 4 an econometric model based

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[1] Layard *et al*. (1991, 1994). A recent survey of the literature is given by Beißinger, Möller (2000).

[2] See e.g. Bound, Johnson (1992), Johnson (1997), Juhn, Murphy, Pierce (1993) for USA, Davis (1992), Blau, Kahn (1996) and Gottschalk, Smeeding (1997) for international comparisons and Fitzenberger (1999), Möller (1999), Steiner, Wagner (1996, 1997) for Germany.

[3] See, for example, Krueger, Summers (1988), Abowd *et al.* (1999, 2001), Haltiwanger, Lane, Spletzer (1999), Möller, Bellmann (1996) and FitzRoy, Funke (1998).

[4] Some major exceptions for Germany are: Jakoby (1990), Haisken-DeNew, Schmidt (1997), Haisken-DeNew, Schwarze (1997), Büttner, Fitzenberger (1998) und Büttner (1999a,b). In these contributions, however, agglomeration effects are not in the center of the analysis.

on the quantile regressions approach is used for estimating spatial wage differentials. The results are discussed and some conclusions are drawn in section 5.

2 Theoretical Background

2.1 Externalities and economies of Scale

Since the classical work of Marshall numerous approaches in regional economic theory deal with the spatial concentration of population and productive resources. Traditionally, the various explanations of the phenomenon either point to the existence of local positive externalities or spatial economies of scale. An influential approach explains a system of cities of different size by referring to specific agglomeration economies[5]. Henderson (1988) argues that economies of scale have a spatial origin: *„...economies of scale are localization ones.“* In the corresponding theoretical model the local wage not only depends on the price of the traded good the location is specialized in, but is also a positive function of the city size.

Ciccone and Hall (1996) chose a different approach. These authors use employment density as measure for the degree of agglomeration and analyze the effect of higher density for the productivity of a specific location. Because of the close relation between the productivity and remuneration of workers, it is also possible to draw conclusions for the spatial wage structure. Ciccone, Hall develop two alternative theoretical concepts. In the first, economies of scale are explained by locational externalities and in the second by the variety of intermediate products. The authors can show that both concepts are equivalent in the sense that they lead to the same estimation approach. According to the empirical results with US data, doubling the employment density entails an increase in productivity of 4 to 6 percent. Evidence cited by Ciccone, Cingano (2001) indicate similar results also for European countries.

2.2 Wage differentials, migration and spatial equilibrium

The increasing integration of markets is reflected by various theories in new regional economics that stress the center/ periphery relationship.[6] This theories have severe implications for economic policy. Domination of centrifugal forces would jeopardize the social and political cohesion within an economic and monetary union. A crucial role plays the close relationship between spatial wage differentials and migration. Spatial wage differentials are an important incentive for migration. Migration flows tend to foster regional adjustments by unburdening the regional

[5] Henderson (1986, 1988).

[6] For example Stahl (1997), Venables (1996, 1997, 1999a,b) as well as Fujita, Krugman, Venables (1999).

labor market after adverse shocks. In equilibrium wage differentials exist only because of purchasing power differences or locational preferences. Hence the persistence of wage differentials that can not be explained by these factors, indicates a lack of efficient adjustment mechanisms.[7]

Theories of functional specialization of regions also have implications with respect to wage differentials. For example, clustering of related industries could lead to technological spillovers and gains from a shared usage of a specific infrastructure thereby generating a comparative advantages for the firms belonging to the cluster. If fairness considerations count in the process of wage formation (for example in the form of rent-sharing), interregional wage differentials would be a consequence. A similar argument can be used by considering the spatial concentration of high skilled workers which is likely to produce an innovative climate. As a consequence, technology leadership and high profits are created which also gives rise to high wage levels.

2.3 Unobserved heterogeneity or true spatial wage differentials?

Regional wage differentials for individuals with identical characteristics that cannot be explained by regional differences in purchasing power, spatial preferences, working or career conditions and job security, indicate disequilibrium or lack of competition. Such discrepancies should vanish in the long run. The question still remains, however, to what extend these discrepancies are caused by unobserved heterogeneity. Following the pioneer work by Krueger, Summers (1988) there exist a analogous dispute with respect to inter-industrial wage differentials. The overwhelming evidence for the existence of wage differentials for observationally equivalent individuals is mostly taken as evidence for efficiency wages, rent-sharing and similar approaches which are based on the assumption of imperfect markets. Adherents of the neoclassical view, however, stress the possibility of selection mechanisms that groups individuals according to their abilities and skills. Measured variables do not reflect this heterogeneity adequately. If taken seriously, the argument reveals that the fundamental controversy of "unobserved heterogeneity" versus "true industry differentials" is still open to debate. Since we do not intend to take up this likely fruitless dispute, we simply assume that at least in the short and medium run wage differentials for observationally equivalent workers are caused by imperfect markets. In the regional context, this point of view seems especially plausible because of high adjustment costs (for example in the case of migration). In our view is seems not very realistic to explain the spatial wage structure by assuming a perfectly competitive labor market. This is especially the case in the context of typical European labor markets where institutional characteristics give rise to significant wage rigidity.

[7] See Möller (2001).

The existing empirical evidence corroborates the view of relatively weak adjustment processes for European countries. Comparing the European countries to the United States there are great differences with respect to the speed of adjustment, especially for migration (Blanchard, Katz (1992), Decressin, Fatás (1995) and Möller (1995)).

3 Descriptive Evidence

3.1 Data and basic definitions

The aim of the present paper is to analyze the agglomeration wage differential for different skill groups in Germany using panel micro data with regional information. Only recently a large sample from social security data was drawn from the Institute of Employment Research, Nuremberg, which contains regional information on a highly disaggregated level and covers the years 1980 to 1997. The data include workers, salaried employees and all trainees as long as they are obliged to pay social insurance contributions. The employment statistics do not include, among others, civil servants, those in marginal employment, students enrolled in higher education and family workers. Being the basis for social security payments the earnings information is highly reliable.[8] Because we are interested in long-run developments the investigation is constrained to the old *laender*. Wages in the data source are daily gross earnings calculated as averages over the observed employment period for every person for each year of the observation period.[9] Since there was a major redefinition of the gross earnings in 1984, we confine the analysis to the time period 1984-1997.

For our study all male employees aged 18 to 55 years who were employed at the 30th of June of each year were selected. Part-time workers, workers in an apprenticeship or volunteers were excluded. The qualifications of workers in the sample can broadly be separated into three categories:

- *low-skilled*: persons with a lower schooling level and no further occupational qualifications completed; this group includes lower and intermediate secondary school secondary school graduates who did not complete an apprenticeship or graduate from a full-time vocational school;

[8] Strictly speaking the focus here is on the spatial structure of *earnings*. In what follows, however, we use the notions "wages" and earnings" interchangeable.

[9] In some rare cases very low earnings were obtained by this procedure. These cases almost surely represent data errors. We decided to exclude cases where daily earnings that did not exceed the double amount of the ceiling for so-called minor employment which is rather low.

- *skilled*: persons with an occupational qualification, which might be either a completed apprenticeship or graduation from a vocational school;
- *high-skilled*: persons holding a secondary school leaving certificate (*Abitur*) and a degree for university or polytechnics type of higher education.[10]

A severe problem for interregional comparisons on a highly disaggregated level is the lack of regional price indices. To make the figures roughly comparable in the time dimension we calculated real daily earnings using an aggregate consumer's price index.[11] We then analyzed the data by grouping it to cells defined by the type of the region, sector affiliation and skill category. In order to identify changes in the lower and upper tail of the distribution not only the median (D5), but also the second (D2) and eighth decile (D8) of the wage distribution were calculated.

While for low-skilled and skilled workers all these deciles are available, only D2 can be calculated for the highest skill category. This is due to the upper ceiling for social security contributions in the German social security system that causes right censoring of the data.

The available regional information refers to the location of the firm, not the residence of the worker. This is an advantage here, because we are interested in the origin and not the spending of gross earnings. In order to differentiate between types of regions we use a classification scheme of the *Bundesanstalt für Bauwesen und Raumordnung* (BBR). This scheme distinguishes between areas with high, intermediate and low population density centers. Within areas of the first category, core cities (RT1), surroundings of core cities (RT2) and rural periphery (RT3) are separated. For the second type we distinguish core cities (RT4) and their surroundings (RT5). To avoid problems with too small cell sizes the rural periphery in intermediate and low population density is grouped together (RT6). This leaves us with six types of regions instead of nine in the BBR classification (for a comparison of the two classification schemes see the appendix).

Table 1 gives some basic information for these six types of regions. Population and employment are strongly concentrated in core cities (RT1 and RT4). The employment share in core cities (44.1 to 47.7 percent) markedly exceeds that of their surroundings and the periphery (26 to 29 percent). The structure of employment clearly varies depending on the type of the region as well. The share of services in core cities is significantly higher than in the other types of regions.

++++++ Table 1 about here++++++

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[10] Additionally there exists a further category: "upper secondary education (*Abitur)* without any further qualification." Because of small case numbers we decided to neglect this category whose share in total employment was rather constant during the observation period.

[11] Of course it would be preferable to deflate nominal wages by a suitable regional price index. Unfortunately, such indices are not available for the regional units and the time period considered. Because of the differences in the regional price *levels* one should be careful with the interpretation of the given figures in so far as the level information is concerned. It can be expected, however, that the bias is less severe when dynamic information is considered.

Of special interest in our context is the employment density (calculated as employment per km^2). This indicator lies between more as 900 (560) employed persons per km^2 in RT1 (respective RT4) and only 33 in RT6. Population density therefore varies by a factor of about 27. For all three main sectors of the economy core cities exhibit the highest and the rural periphery (RT6) the lowest employment density. The discrepancy is highest in the service sector (factor 37), whereas in Manufacturing it is about 18.

According to *Table 2* the prices of building land in metropolitan areas are about six times higher than in the rural periphery. Both types of core cities (RT1 and RT4) are leading with respect to qualification indices (average years of schooling respectively and share of high-skilled workers), but also suffer from the highest unemployment rates.

3.2 Changes in the spatial wage structure

3.2.1 Wage differentials between core cities and the rural periphery

First we present descriptive evidence by contrasting both type of core cities (Rt1 and RT4) to the rural areas (RT6). A graphical overview of the results is given in *Figures 1* to *4*. Here we consider the real daily wages (in 1995 DM) and concentrate on the spatial pay differential in absolute value. *Figure 1* shows that this absolute differential for low-skilled workers in Manufacturing exceeds the corresponding one in Services.

The urban/rural wage pattern varies depending on the qualification of the workers and the sector of the economy. The spatial earnings differential for unskilled workers in Manufacturing remains almost constant between 1985 and 1997. Only the second decile tends to rise slightly. By contrast, the core city/rural discrepancy in the service sector changes noticeably with a remarkable asymmetry. While in the left tail of the earnings distribution and for the median the gap has diminished considerably, a certain increase in the right tail can be observed.

Considering the second decile of skilled workers we see no striking changes in the different sectors. In Manufacturing, a slight increase of the spatial pay differential for the eight decile can be detected and analogously for the median in Services. Again the earnings gap seems to be larger in Manufacturing than in Services, but the differences are not substantial. As is the case for low-skilled workers, the agglomeration differential in absolute values increases monotonically with the decile of the wage distribution.

++++++ Figure 1 and 2 about here ++++++

According to the descriptive evidence the agglomeration differential is in the order of magnitude of the skill differential between the lowest and intermediate skill group. For example the average

earnings of a low-skilled worker in a core city equals those of a skilled worker in a rural area. This relation holds for both tails of the earning distribution.

The changes are considered from a different perspective in *Figures 3* and *4*. Within these figures we differentiate by qualification, so that the vertical distance between the two lines stands for the skill differential in 1995 DM. We see that specially D8 exhibits a qualification gap between core cities (on the left-hand side) and rural areas (on the right-hand side). A comparison of *Figures 3* and *4* leads to the conclusion that in both types of regions the skill based wage differential in Services exceeds that in Manufacturing.

++++++ Figure 3 and 4 about here ++++++

3.2.2 Wage increases and the agglomeration wage differential by skills and sector

Low-skilled workers

In the left panel, *Table 3* contains daily real wages and the corresponding relative changes by sector and type of the region for the years 1985 and 1997. In the manufacturing sector, real wage growth was positive for all deciles of the wage distribution. All growth rates are in the range of 10 to 14 percent with the highest values found for D8. In contrast to this rather homogenous development, real wage growth in the service sector differs markedly between the different deciles of the wage distribution. On the one hand, the figures indicate real wage *losses* for the second decile (D2) which are quite substantial in the case of core cities (-7.8%). On the other hand, we find clear evidence of real wage growth for the fifth and eighth decile real wage (D5 and D8) although the increase is somewhat lower compared with the manufacturing sector.

++++++Table 3 about here ++++++

Let us now define the *agglomeration wage differential* as the difference between the corresponding deciles of the wage distribution of core cities and rural areas as a percentage of the latter. Considering the manufacturing sector first, we observe that the agglomeration wage differential for low-skilled workers is between 14 to 17 percent for and above the median wage and takes somewhat lower values (11 to 13 percent) for the left tail of the wage distribution (D2). Over time, the agglomeration wage differential has remained more or less stable for all deciles of the wage distribution. If anything, there is a slight tendency to increase for D2 and to fall for D5 and D8.

A comparison of the lower and upper panel of *table 3* reveals that the agglomeration wage differential for low-skilled workers in the service sector is generally lower than in Manufacturing. In 1985 the differential was 7 to 8 percent over the whole range of the wage distribution. Within the observation period, this measure increases in the upper part of the distribution (D8), falls to half its previous value for D5 and melts away for D2. As a result, the 1997 agglomeration wage

differential for low-skilled workers in Services is monotonically increasing with the decile of the wage distribution.

Skilled workers

In the right-hand panel, *Table 3* contains information on the real wage of skilled workers. For this group of workers real wage growth in the observation period has been positive for all sectors and deciles of the wage distribution with growth rates ranging from 10 to 16 percent. As for the low skilled, real wage growth between 1985 and 1997 was somewhat higher in Manufacturing than in Services.

Although the agglomeration wage differential in both sectors tends to decrease over time, it remains substantial at the end of the observation period. All in all, the "spatial wage gap" appears to be much more dissimilar over the wage distribution than for low-skilled workers. In 1997, it ranges from roughly 13 to 25 percent in Manufacturing, and from 9 to 20 percent in Services. Moreover, one can observe that the agglomeration wage differential for skilled workers is generally smaller in the left tail of the distribution than in the right one, i.e. it increases monotonically with the decile considered.

High-skilled workers

Table 4 contains information on the real wage of high-skilled individuals which is only available for the second decile because of ceiling problems. The biggest increase in the real wage between 1985 and 1997 is found for Manufacturing in core cities (about 16%) and the lowest for Services in rural areas (about 3%). In contrast to the group of skilled workers – where the agglomeration differential for D2 decreases over time – , the "spatial wage gap" here almost doubles between 1985 and 1997 in both sectors.

The skill premium for skilled and high-skilled workers

Table 5 gives information on the skill premium. On the one hand, we consider the percentage wage differential the intermediate and highest skill category receives over the lowest, and on the other hand the premium of the highest skill category over the intermediate. We first interpret the relative wage differential of skilled versus low-skilled workers. At least five items are worth to be mentioned.

++++++ Table 5 about here ++++++

First, there are remarkable differences in the skill premium with respect to the sector, the type of the region and the decile of the wage distribution. For example, the wage differential between skilled and low-skilled workers ranges from roughly 6 percent for low-wage (D2) manufacturing workers in rural areas to about 46 percent for metropolitan low-wage workers in the service sector. Second, the skill premium is generally higher in the service sector. Third, with the excep-

tion of service industries in rural areas, the skill premium is highest at the top of the wage distribution. Fourth, the skill premium in regions with high population density typically exceeds that of rural areas.

Figure 5 gives information on the size and the development of the skill premium in both types of regions. The same scale is used for presenting the relative wage gap in core cities (horizontal axis) and rural areas (vertical axis) for 1985 and 1997. The arrows connect these two points and represent the change over time. The 45°-line represents combinations where the skill premia are equal in both types of regions. It becomes evident from the figure that with only one exception all points are below the 45°-line indicating a higher skill premium in core cities. Put differently, something like an *agglomeration bonus for the skill premium* does exist according to our results. Such a bonus is visible for all deciles of the wage distribution at the beginning and the end of the observation period. The only exception can be found in the lower tail of the wage distribution in Manufacturing, where the spatial differences in the skill premium have been eroded from 1985 to 1997.

Furthermore, since all arrows point in the direction North-East, the skill premium increases over time. This is especially the case for the service sector. In both types of regions the skill premium in Services tends to exceed the corresponding one in Manufacturing. Together with the evidence from *tables 3* and *4* one can conclude that the higher skill differential in low-paid service jobs is not caused by an extraordinary increase in the wage for skilled workers, but by high wage losses for the low-skilled in the left tail of the wage distribution.

++++++Figure 5 about here++++++

We now turn to the skill premium for high-skilled workers which is only available for the second decile (see the last two columns of *table 5*). With respect to the sector affiliation and the type of the region there are eye-striking differences. In 1997, high-skilled workers in Manufacturing obtain a remuneration that exceeds that of low-skilled workers by about 70 percent in rural areas, while the corresponding figure for service industries in metropolitan areas is about 119 percent. Again, one can observe that the relative wage differential with respect to low-skilled workers is higher in Services.

Moreover, remarkable changes appear during the observation period. In rural areas, the skill premium of graduates from universities and polytechnics vis-à-vis the low and intermediate skill category has declined from 1985 to 1997 in three out of four cases. In core cities, an opposite tendency can be observed. For this type of region an increase in the skill premium can be noticed in the majority of cases.

A further aspect concerns regional differences with respect to the skill premium. In 1985, an agglomeration bonus of the skill premium for the high skilled did only exist vis-à-vis low-skilled manufacturing workers. In three out of four cases the corresponding skill premium was even higher in rural areas than in core cities. By the end of the observation period, the picture has clearly changed. A marked agglomeration bonus now shows up in both sectors and types of regions.

4 Econometric Analysis

4.1 Methodology

The descriptive results presented already yield valuable insight into the structure and development of spatial wage differentials. However, the reliability of the analysis is restricted insofar as the potential heterogeneity within the various groups of workers distinguished here is not taken into account. It is well know, for instance, that the wage depends on experience and/or tenure of the worker. Given that workers with different characteristics are not evenly distributed over the different types of regions the descriptive results could give rise to wrong conclusions. A suitable econometric analysis can control for this heterogeneity. Moreover, it becomes possible to draw conclusions in the light of statistical inference.

In what follows, we use a quasi quantile regression technique approach put forward by Chamberlain (1994).[12] The approach requires a lot of case numbers, a constraint that is fulfilled by the data set. Chamberlain proposes to form homogenous cells and to calculate various sample quantiles within each cell. He chooses a minimum-distance estimator for the conditional quantile functions. The author refers to the contributions of Powell (1984, 1986) and suggests a simple solution to the censoring problem, which amounts to using only cells for which the sample quantile falls below the censoring point. For the minimum-distance weight matrix it is convenient to choose a diagonal matrix with the cell sizes as the corresponding elements. Then one can use the convenient result that a GLS-estimator is approximately equivalent to the more sophisticated quantile regression estimation approach.

We partition the sample for every year into cells divided by type of the region, sector experience and skill group. More specifically, we consider three skill groups[13], two sectors of the economy

[12] This method has been applied in an extended form for German wage data by Fitzenberger (1999).

[13] The censoring problem appears to be very severe for high qualification groups. For low-skilled and skilled workers. the censoring problem is almost negligible if only D2, D5 and D8 are considered.

(Manufacturing and Services), six types of regions[14] and eight categories of potential work experience[15]. This yields a maximum of 3 x 2 x 6 x 8 = 288 cells in each year of the 14-year observation period from 1984 to 1997. For each cell, the log D2, D5 and D8 deciles of the real gross earnings are calculated. As recommended by Chamberlain, all cells consisting of less than 30 observations were excluded from the sample.[16]

Instead of pooling all cells, we consider separate sector-specific estimations for all skill groups. Our estimation approach includes five (0,1)-dummies for the type of the region with rural areas as the reference category to measure the agglomeration earnings differential. Fixed effects are also used for the 14 points of observation as well as interaction terms in order to capture a specific time trends for the type of region. The workers' (potential) on-the-job experience is measured as age minus average time of education minus 6.[17] Since it is well-known from the literature on Mincer-type wage equations (Mincer 1974) that the workers' experience/wage profile is concave, squared experience is included besides the experience variable. Moreover, we allow for the possibility that factors specific to the type of the region could affect the experience/wage profile.. We also consider the possibility that the general pattern of the experience/wage profile has changed over time. The estimation equation for each sector and skill group is as follows:

$$w_{irt} = \alpha_0 + \alpha_r + \beta_{rt} + \gamma_1 ERF_{it} + \gamma_2 ERF_{it}^2 + \delta_t + \varepsilon_{irt}, \qquad (1)$$

where the left-hand variable denotes log earnings (D2, D5 or D8) for age group i $(i = 1,..,8)$, type of the region r $(r = 1,..,6)$ and time period t $(t = 0,..,13)$. For the effect of the type of the region a_r we choose RT6 as reference category ($a_6 = 0$). The parameter b_{rt} is related to the cross effect between the type of the region and a linear time trend. As an identifying restriction we imposed that the weighted sum of all interaction effects is equal to zero. For the weights in these restrictions we use the cell sizes for the year 1992. The estimation then offers sensible interpretations: The corresponding coefficients reflect deviations of a linear trend specific to the type of the region from the development in the aggregate.[18] EXP_i stands for the (potential) experience of age group i and ε_{irt} is a disturbance term with the usual properties.

[14] We distinguish (i) core cities in high density agglomerations; (ii) surroundings of core cities in high density agglomeration; (iii) rural periphery of core cities in high density agglomerations; (iv) core cities in medium density agglomerations; (v) surroundings of core cities in medium density agglomeration; (vi) rural periphery in areas of medium and low population density.

[15] The groups are categorized as follow: 0-5, 6-10, 11-15, 16-20, 21-25, 26-30, 31-35, 36 or more years of potential work experience.

[16] Since we are using the sample size as weighting variable, the weight of cells with few observations becomes small. For the first two categories of workers (low skilled and skilled), the cell sizes are quite beyond the limit of 30 in most cases.

[17] For a low-skilled (skilled) worker the average time of education is taken as 10 and 12,125 years, respectively. For a high-skilled worker we took the average time of education necessary for a university degree and a degree from a polytechnics (16.5 years).

[18] See Greene, Seaks (1991) for this modeling strategy. It should be stressed that we did not chose a similar specification for the effect of the type of the region. The reason is that the agglomeration differential is defined not with respect to the aggregate but with respect to the type of the region with the lowest population density.

Eq. **(1)** is estimated by GLS with variance/covariance matrix Ω and $\Omega^{-1} = W$, where W is a diagonal matrix with the cell size corresponding to the respective observation as typical element.

4.2 Estimation Results

4.2.1 Specification Tests

Table 6 contains the results of Wald-F-tests for exclusion of regressor variables. As expected, the fixed time effect exhibits a high level of significance. According to the results, also the spatial characteristics have a highly significant influence on wage formation. With respect to the interaction variable being included to model specific trends for the type of the region, the results are ambiguous. For the lowest skill category the test statistic is significant in four out of six and for the highest skill category in all estimation equations. In these cases one has to concluded that specific trends for the spatial wage differentials do exists in different types of regions. For the intermediate skill category, however, a statistically significant result shows up only for the upper tail of the wage distribution in Services. In all other cases we have to conclude that the agglomeration differential is quite stable for this skill group.

We do not present details for the estimation results for the experience variables and for the fixed time effects.[19] With respect to the sign all estimated coefficients for the former are in line with theoretical expectations. Moreover, the estimates are statistically significant at least at the 1 percent level with only one exception (the concavity coefficient of D5 for the highest skill category in Manufacturing which is not significant). The general pattern obtained from the estimates of the fixed time effects corroborate the descriptive results

4.2.2 The agglomeration wage differential

In what follows we concentrate on the spatial wage structure. *Table* 7 contains the estimated relative earnings differential for region type RT1 to RT5 with respect to rural areas of type RT6 for the years 1984 and 1997. The general pattern of this differential is quite stable over the observation period. One can observe remarkable differences with respect to the qualification of workers, the type of the region and the sector of the economy. All estimated differentials are positive and mostly significant, indicating that workers in high-density regions earn more than in the rural periphery of low-density areas. The quantile regression approach supports that the result is robust even if one controls for differences in experience.

+++ table 7 about here +++

[19] These results are available from the authors on request.

In comparison to the descriptive results it turns out that the estimated agglomeration wage differentials are somewhat lower. Thus one can conclude that descriptive evidence which does not consider heterogeneity of workers with respect to experience tends to overestimate spatial wage discrepancies.

In contrast to the descriptive analysis, it is now possible to analyze the results more precisely. The spatial pattern of wages in the different types of regions seems to depend strongly on employment density. We find the highest differential for both type of core cities (RT1 and RT4) and for the surroundings of the metropolitan cities (RT2).

With few exceptions the agglomeration wage differential in Manufacturing exceeds that in Services. For example in the year 1997 the agglomeration wage differential of low-skilled manufacturing workers in core cities of the second type (RT4) was about 14 percent for the median, while for workers of the same skill category in Services it was about 2 to 3 percent only. For high-skilled workers in the service sector of metropolitan cities (RT1) we find an agglomeration wage differential of about 17 percent for D2, whereas in Services the corresponding value is roughly 11 percent. Intersectoral differences are weaker for the intermediate qualification group, but – except for RT3 – not negligible.

Although there are some exceptions, it can be observed that the agglomeration wage differential tends to increase with higher qualification and the decile of the earnings distribution. These results corroborate the basic patterns already described in section 2. The econometric estimates, however, reveal a variety of further specific aspects. For example in Manufacturing the highest earnings differential is found for low-skilled workers in the second type of core cities (RT4) and not in metropolitan cities (RT1). In the service sector the interregional pattern for this skill category are even more disperse. In the year 1997 the D2 differential for metropolitan cities belongs to the lowest of all types of regions whereas the D8 differential is the highest. For qualified workers there exist a strong linkage between the spatial wage level and population density. Here we find the highest values in core cities (RT1 and RT4) as well as in surroundings of metropolitan cities (RT2). The earnings situation in the latter type of region is especially favorable for qualified service workers.

With respect to the development of the agglomeration wage differential over time we obtain unambiguous evidence for the low-skilled group. In all cases where the difference between 1984 and 1997 is statistically significant, there is a *decrease*. This leads to the conclusion that spatial earnings differentials for low-skilled workers tend to equalize. For the intermediate skill category there is no clear picture. In the manufacturing sector we also find that the spatial wage differential is reduced. In Services, however, marked changes only occur for top-wage earners (D8). The spatial wage differential for this group seem to shrink in metropolitan core cities, but increases

in their surroundings (RT2). As a consequence, the results indicate that wages between RT1 and RT2 are equalized over time for this group of workers. However, an analogous phenomenon does not show up for core cities of the second type (RT4) and their surroundings (RT5). Here the agglomeration differential increases in both cases.

With respect to highly-qualified manufacturing workers we confine our interpretation to the second decile. In this sector the estimates are based on a small number of cells only and, therefore, should be considered with caution. Due to a higher number of observations, the results for the median in the service sector are clearly more reliable.

Comparable to the intermediate skill category, the spatial wage differentials for high-skilled workers are highest in metropolitan core cities (RT1). The mark-up that this group or workers receives in RT1 relative to the rural periphery of low-density regions, amounts to 17.5 percent in Manufacturing and 11.5 percent in Services. A further remarkable result shows up for the surroundings of metropolitan core cities. High-skilled workers in the service sector receive the highest earnings in this type of region and not in the core city itself.

It seems noteworthy that different developments over time show up in the two sectors of the economy. While we obtain quite stable spatial earning differentials for high-skilled manufacturing workers, there are substantial changes in Services. Except for RT5, the agglomeration wage differential as measured by the second decile of the wage distribution is increasing for all types of regions. The results for the median tend to support this finding.

In order to investigate the different forces influencing the agglomeration wage differential, a regression approach is used to explain the estimated values. In the initial specification we ran a regression for the logarithmic agglomeration wage differential (augmented by 100) on a constant and the logarithmic density of population in the specific type of region. In a first variant we applied this approach by pooling all data. Then we ran separate regressions for Manufacturing (variant 2) and Services (variant 3). The results are reported in column (1) to (3) of *table 8*. The results indicate, that the elasticity of the spatial wage differential with respect to population density is statistically significant different from zero in all cases. According to variant (1) the elasticity is 2.5 percent. The result implies, that a doubling of population density in average leads to a 2.5 percentage point increase of the agglomeration wage differential. In the light of variants 2 and 3, one can observe that a higher elasticity is obtained for Manufacturing (3.3) than for Services (1.8). In both cases the coefficient is highly significant.

Furthermore we tried to analyze the influence of other factors on the agglomeration wage differential by including additional regressors in the estimating equation. On the one hand we controlled for special effects in the median and upper tail of the wage function and on the other hand for the effect of the qualification level and sector affiliation.

The results are reported in column (4) of *table 8*. It turns out that no significant effect is found for the median. The effect for the eighth decile, however, is statistically significant. Hence it can be concluded that the agglomeration wage differential is considerably higher in the upper than in the intermediate and lower tail of the wage distribution. Furthermore, we can identify a significant influence of the intermediate and upper skill category on the agglomeration wage differential.[20] As already could be expected on the basis of the separate estimations, there is a positive and highly significant effect of the manufacturing sector on the wage differential. Hence the basic results of our interpretation from above are confirmed by the regression analysis.

+++ Table 8 about here +++

5 Conclusions

The aim of the paper was to reinvestigate the spatial wage structure by using a large panel micro data set. Our results confirm the hypothesis that an agglomeration wage differential does exist even if one controls for the qualification, experience and sector affiliation of workers. According to the estimation results, employees in core cities earn up to 25 percent more than their observationally equivalent colleagues in rural areas. Hence the spatial wage gap is not negligible. In the average, the agglomeration wage differential is in the order of magnitude of the skill premium workers of the intermediate skill category receive with respect to the low-skilled.

Our estimation approach yields a value of 0.025 for the average elasticity of the spatial wage differential with respect to population density. Hence duplicating the number of jobs per unit of land leads to an increase in the level of earnings of about 2.5 percent. This result can roughly be compared to the value of 4-6 percent found by Ciccone, Hall (1996) for US data. The latter result, however, refers to productivity, not wages. If the wage differentials reflect underlying discrepancies in productivity, one can conclude that agglomeration effects are somewhat stronger in the US.

A closer analysis reveals that the agglomeration wage differential is not uniform. Although not all findings fit into a simple pattern, some general conclusions can be drawn. The spatial differences increase with the skill level and the decile of wage distribution. Moreover, significant differences show up between the sectors of the economy. Typically, the agglomeration wage differential in Manufacturing is higher than in Services. In the latter sector the findings strongly depend on the qualification of workers. This is especially the case for agglomeration areas. An eye

[20] The effect for the intermediate skill category is even stronger than for the highest. Because of a substantially lower number of observations for high-skilled workers and the corresponding variability of the estimates one should be careful with the interpretation of this result.

striking detail is the complete erosion of the agglomeration wage differential for low-skilled workers in the lower part of the wage distribution within the observation period. Considering the higher costs of living in metropolitan areas, workers in that category are evidently worse-off than their colleagues living in the rural periphery. A deeper investigation of the phenomenon, however, is beyond the scope of the present paper.

The fact that the agglomeration wage differential depends on qualification, sector affiliation and the position in the earning hierarchy rules out the possibility to explain the spatial wage pattern entirely by regional differences in the costs of living. The reason is that differences in purchasing power are likely to affect all groups of workers of the same location in a similar way. The same applies to other explaining factors that do not vary with the characteristics of the different groups of workers. For example, one could think of common preferences for or against living in an agglomeration.

Our results imply that, in the regional dimension, earnings are more compressed in the lower tail of the distribution. Hence, from a different perspective the evidence here supports the findings by Blau, Kahn (1996) who find that especially below the median wage dispersion in continental European countries is quite lower than in the United States, for example. This asymmetry in the wage distribution possibly reflects differences in institutional settings.[21] It could be argued that the effect is caused by minimum wages. In the German labor market wages are determined by negotiations between unions and associations of employers. Firms being members of an employers association are obliged not to pay below the negotiated wage. Hence negotiated wages can be characterized as minimum wages *de facto.* Frequently this system of wage negotiations is blamed for the wage compression *in the left tail of the distribution.*. A simple consideration, however, reveals that binding minimum wages also affects the quantile differences in the upper tail of the wage distribution. It is possible that changes caused by a binding minimum wage restriction are completely symmetrical in the lower and upper tail of the wage distribution.[22]

In face of the empirical evidence, we doubt that institutional settings alone can give an sufficient explanation of the observed phenomena. Our findings support the view that marginal productivity of the intermediate and high-skill workers increases more than proportionally with the decile of the wage distribution, whereas this is not the case for the low-skilled. This increase is more significant in regions with high population density. Hence wage inequality for skilled and

[21] A similar argument is used by Büttner, Fitzenberger (1998) in a wage curve approach. They find that wage flexibility with respect to the regional unemployment rate is lower for unskilled workers.

[22] This can be explained as follows: Assume that wages reflect marginal productivity and let the quantiles of marginal productivity follow a linear function. A binding minimum wage restriction cuts off employment of workers whose productivity falls short of a critical level. This yields a different "quantile function" which starts at the minimum wage level and ends at the same point as in the non-restricted case at the top of the distribution. The new curve is flatter than the curve without a binding minimum wage, but it is still linear. Hence the differences between quantiles are symmetric around the median. The example shows that the minimum wage typically affects inequality measures not only in the left tail but also in the right tail of the distribution.

high-skilled workers is more pronounced in core cities. As a tentative explanation of this phenomenon we would suggest that talented, motivated and well-educated individuals are able to benefit more from agglomeration advantages than others.

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Appendix

A1: A regional classification scheme

The Federal Office of Building and Planning (BBR) provides a system for the classification of regions (counties) in Germany. Its purpose is monitoring different regional situations and developments [see Görmar/Irmen (1991)].

The classification is based on two criteria: „size and/ or centrality of the biggest center of a region“ and „location within the region “. Three different structural types are distinguished:

Regions with large agglomerations:

Regions that include metropolitan areas with high population potential; centers are defined as municipals with more than 300.000 inhabitants and/or areas where the population density exceeds 300 inhabitants per km².

Regions with intermediate agglomerations:

Regions with a low density core, particular characterized by strict rural surroundings, their centers represent emerged industry or service locations; normally the core cities are upper-level centers with more than 100.000 inhabits and a population density over 150 inhabitants per km².

Regions of rural character

Regions, that are situated in a commuter belt of larger density areas. Typically there are no upper-level centers above 100.000 inhabits; the population density does not exceed 150 inhabitants per km².

Table A1 presents an overview for the different types of regions and the district types that form a region.

Table A1:

Region types based on BBR-Classification

Structural region type	District type (BBR-Classification)	region types (RT) used in the paper	Description of region type (BBR)
Regions with large agglomerations	BBR 1	RT1	Core cities
	BBR 2	RT2	Highly urbanized districts in regions with large agglomerations
	BBR 3	RT3	Urbanized districts in regions with large agglomerations
	BBR 4	RT3	Rural districts in regions with large agglomerations
Regions with features of conurbation	BBR 5	RT4	Central cities in regions with intermediate agglomerations
	BBR 6	RT5	Urbanized districts in regions with intermediate agglomerations
	BBR 7	RT6	Rural districts in regions with intermediate agglomerations
Regions of rural character	BBR 8	RT6	Urbanised districts in rural regions
	BBR 9	RT6	Rural districts in rural regions

Aggregation of region types used for description in Tables 2 to 4 and Figures 1 to 5:

Core cities, RT1 and RT4; Rural area (Periphery), RT6;

The available regional information refers to the work place and not the place of residence. This is an advantage for our purpose because we are interested in the origin and not the spending of gross earnings.

Table 1: Selection of data

	number of cases
total number of individual observations 1984-97	3 322 567
part-time workers excluded	3 059 454
males only	1 801 983
with valid earnings information	1 531 071
age 18-55	1 378 058
with valid regional information	1 365 202
exclusion of skill groups not considered here	1 255 026
number of cases used in our sample, thereof	1 255 026
- low-skilled workers	248 813
- skilled workers	974.857
- high-skilled workers	31.356

Table 2: **Indicators for the different types of regions**

	RT1	RT2	RT3	RT4	RT5	RT6
Area in km2	7247	24123	35804	2922	61893	116466
Population (in 1000)	14927.0	12706.7	6971.4	3428.4	13241.9	13272.7
Employment (in 1000)#	6577.3	3681.1	1810.9	1635.5	3811.7	3813.5
Employment/Population (in percent)	44.1	29.0	26.0	47.7	28.8	28.7
Employment/km^2	907.6	152.6	50.6	559.7	61.6	32.7
Employment in the primary sector (percent of total employment)	0.4	1.0	1.5	0.4	1.1	1.5
Employment in Manufacturing (percent of total employment)	30.3	46.4	41.7	33.1	48.0	47.2
Employment in Services (percent of total employment)	69.3	52.6	56.9	66.5	50.8	51.3
Employment in primary sector per km^2	3.6	1.5	0.7	2.2	0.7	0.5
Employment in Manufacturing per km^2	275	71	21	185	30	15
Employment in Services per km^2	629	80	29	372	31	17
Unemployment rate (percent)	12.5	8.8	8.4	12.6	8.8	8.4
Cost of building land (DM per m^2)	612	291	159	274	139	91
Average duration of training per worker (in years)	12.58	12.17	12.11	12.38	12.05	11.99
Share of high-skilled workers (in percent)	12.4	7.8	5.4	8.7	5.2	3.9

Notes: Own calculations on the basis of the INKAR data base (Federal Office of Building and Regional Planning, data for 1998) and; Average duration of training for employment population and employment population of high skilled are calculated for the year 1997 with data from the employment register of the Federal Labor Office (IAB-REG, see Möller, Haas (2001)); # employment covered by social security;

Table 3:
Real daily earnings of low-skilled and skilled workers by sector and type of the region (1985 and 1997 in DM of 1995)

	Manufacturing					
	Low-skilled workers			Skilled workers		
	D2	D5	D8	D2	D5	D8
	1985					
Core cities	112.2	134.7	157.1	124.7	152.1	195.8
Rural areas	101.0	116.0	134.7	107.2	125.9	154.6
		Percent			*Percent*	
Difference	**11.1**	**16.1**	**16.7**	**16.3**	**20.8**	**26.6**
	1997					
Core cities	126.0	149.2	177.3	139.5	173.4	223.8
Rural areas	111.4	130.8	154.1	124.0	146.3	179.3
		Percent			*Percent*	
Difference	**13.0**	**14.1**	**15.1**	**12.5**	**18.5**	**24.9**
	Change 1997/1985					
		Percent			*Percent*	
Core cities	**12.3**	**10.8**	**12.9**	**11.9**	**14.0**	**14.3**
Rural areas	**10.3**	**12.8**	**14.4**	**15.7**	**16.2**	**15.9**
	Services					
	Low-skilled workers			Skilled workers		
	D2	D5	D8	D2	D5	D8
	1985					
Core cities	93.5	120.9	144.6	114.7	144.6	198.3
Rural areas	87.3	112.2	134.7	102.2	128.4	158.4
		Percent			*Percent*	
Difference	**7.1**	**7.8**	**7.4**	**12.2**	**12.6**	**25.2**
	1997					
Core cities	86.2	126.0	159.9	126.0	162.8	221.9
Rural areas	86.2	121.1	145.3	115.3	144.4	185.1
		Percent			*Percent*	
Difference	0.0	**4.0**	**10.0**	**9.2**	**12.8**	**19.9**
	Change 1997/1985					
		Percent			*Percent*	
Core cities	**-7.8**	**4.2**	**10.5**	**9.8**	**12.6**	**11.9**
Rural areas	-1.2	**7.9**	**7.9**	**11.8**	**11.7**	**15.7**

Table 4:
Real daily earnings of high-skilled workers by sector and region type
(1985 and 1997 in DM of 1995)

	D2 Manufacturing	D2 Services
	1985	
Core cities	203.2	174.6
Rural areas	179.6	163.3
	Percent	
Difference	**13.2**	**6.9**
	1997	
Core cities	236.4	189.0
Rural areas	190.0	168.6
	Percent	
Difference	**24.5**	**12.1**
	Change 1997/1985 in percent	
Core cities	**16.3**	**8.2**
Rural areas	**5.8**	**3.2**

Table 5:
Skill premium by sector and type of the region in percent (1985 and 1997)

	Manufacturing					
	Skilled versus low-skilled workers				High-skilled workers versus skilled	low-skilled
	D2	D5	D8	D8-D2	D2	D2
	1985					
Core cities	11.1	13.0	24.6	13.5	63.0	81.1
Rural areas	6.2	8.6	14.8	8.6	67.4	77.8
Difference	**4.9**	**4.4**	**9.8**	**4.9**	**-4.4**	**3.3**
	1997					
Core cities	10.8	16.2	26.2	15.5	69.4	87.7
Rural areas	11.3	11.9	16.4	5.0	53.1	70.4
Difference	-0.5	**4.4**	**9.9**	**10.4**	**16.3**	**17.3**
	Change in percentage points 1997/1985					
Core cities	-0.3	3.3	1.6	**2.0**	**6.4**	**6.6**
Rural areas	**5.1**	**3.2**	1.5	**-3.6**	**-14.3**	**-7.3**
	Services					
	Skilled versus low-skilled workers				High-skilled workers versus skilled	low-skilled.
	D2	D5	D8	D8-D2	D2	D2
	1985					
Core cities	22.7	19.6	37.1	**14.4**	52.2	86.7
Rural areas	17.1	14.4	17.6	0.4	59.8	87.1
Difference	**5.5**	**5.1**	**19.5**	**14.0**	**-7.6**	-0.5
	1997					
Core cities	46.1	29.2	38.8	**-7.3**	50.0	119.1
Rural areas	32.6	18.4	26.0	**-6.6**	47.5	95.5
Difference	**13.5**	**10.8**	**12.8**	-0.7	**2.5**	**23.6**
	Change in percentage points 1997/ 1985					
Core cities	**23.4**	**9.6**	1.7	**-21.7**	**-2.2**	**32.4**
Rural areas	**15.4**	**4.0**	**8.4**	**-7.0**	**-12.3**	**8.4**

Table6:
Results of Wald-F-Test for exclusion of regressor variables

	Low-skilled workers					
	Manufacturing			Services		
	D2	D5	D8	D2	D5	D8
RT	60.99**	196.69**	239.33**	14.44**	27.11**	37.53**
RT x *TIME*	0.44	4.91**	4.62**	5.48**	2.78*	1.04
TIME	81.49**	185.30**	211.94**	15.78**	44.08**	62.51**
N	632	632	632	600	600	600
	Skilled workers					
	Manufacturing			Services		
	D2	D5	D8	D2	D5	D8
RT	72.17**	175.61**	203.65**	51.79**	142.92**	126.98**
RT x *TIME*	1.42	1.88	1.26	0.71	1.15	5.08**
TIME	99.47**	148.64**	156.03**	69.84**	142.54**	77.05**
N	657	657	601	646	646	577
	High-skilled workers					
	Manufacturing			Services		
	D2	D5	D8	D2	D5	D8
RT	19.22**	12.67**	-	17.65**	10.06**	-
RT x *TIME*	3.22**	2.54*	-	2.80*	6.53**	-
TIME	26.14**	41.27**	-	21.05**	25.10**	-
N	232	92	-	397	197	-

Notes: RT: dummy variables of region type; *RT* x *TIME*: interaction term between region type and linear time trend; *TIME:* fixed time effects; *N*: number of available cells. See main text for specification. Estimation methodology: GLS under identifying restrictions using cell size as weight factor. ** and * significanct at the 1 respective 5 percent level.

Table 7: **The estimated agglomeration wage differential (in percent)**

	Low-skilled workers					
	Manufacturing			Services		
	D2	D5	D8	D2	D5	D8
	1984					
RT1	**9.824**	**11.653**	**13.741**	**8.744**	**8.821**	**9.252**
RT2	**9.469**	**12.180**	**14.578**	**7.121**	**7.831**	**7.808**
RT3	1.322	**1.930**	**3.918**	**4.556**	**3.725**	**4.162**
RT4	**12.361**	**19.272**	**19.639**	**8.533**	**5.769**	0.930
RT5	**5.386**	**5.997**	**8.217**	**3.393**	**4.757**	**2.663**
	1997					
RT1	**9.499**	**10.541**	**12.436**	**3.420**	**4.080**	**7.520**
RT2	**7.903**	**8.858**	**11.226**	**7.856**	**4.681**	**6.057**
RT3	0.301	**1.891**	**1.973**	**6.684**	**3.120**	**2.790**
RT4	**11.385**	**14.324**	**13.752**	**3.429**	**2.537**	**2.797**
RT5	**5.347**	**5.835**	**5.623**	**6.380**	**2.226**	**2.544**
	changes					
RT1	-0.325	-1.112	-1.304	**-5.324**	**-4.741**	-1.733
RT2	-1.567	**-3.323**	**-3.352**	0.735	**-3.150**	-1.752
RT3	-1.021	-0.039	**-1.946**	2.127	-0.605	-1.372
RT4	-0.976	**-4.947**	**-5.886**	**-5.105**	**-3.232**	1.867
RT5	-0.039	-0.163	**-2.594**	2.987	**-2.531**	-0.120
	Skilled workers					
	Manufacturing			Services		
	D2	D5	D8	D2	D5	D8
	1984					
RT1	**12.441**	**16.622**	**16.851**	**9.704**	**13.253**	**17.289**
RT2	**9.953**	**14.153**	**15.315**	**7.454**	**9.863**	**12.457**
RT3	**2.497**	**3.992**	**4.788**	**2.567**	**4.819**	**5.922**
RT4	**9.252**	**12.197**	**12.032**	**5.120**	**4.918**	**6.757**
RT5	**4.490**	**5.929**	**6.335**	**2.896**	**2.758**	**2.638**
	1997					
RT1	**10.395**	**15.820**	**16.308**	**8.575**	**12.682**	**14.753**
RT2	**7.582**	**10.888**	**13.572**	**6.626**	**10.777**	**15.015**
RT3	**2.397**	**2.862**	**5.490**	**3.971**	**5.217**	**6.592**
RT4	**8.358**	**11.526**	**12.595**	**4.343**	**6.171**	**9.614**
RT5	**4.890**	**5.669**	**7.063**	**2.893**	**4.117**	**5.634**
	changes					
RT1	**-2.046**	-0.802	-0.543	-1.129	-0.570	**-2.536**
RT2	**-2.371**	**-3.265**	**-1.743**	-0.828	0.914	**2.558**
RT3	-0.100	-1.130	0.702	1.404	0.398	0.670
RT4	-0.894	-0.670	0.562	-0.778	1.253	**2.856**
RT5	0.401	-0.260	0.728	-0.003	1.360	**2.997**

Note: Coefficients at least significant at the 5% level in bold types.

Table 7 (continued): **Estimated agglomeration wage differential**

	High-skilled workers					
	Manufacturing			Services		
	D2	D5	D8	D2	D5	D8
	1984					
RT1	**14.083**	**11.056**	-	**6.566**	1.731	-
RT2	**13.066**	**10.841**	-	**4.341**	2.865	-
RT3	1.462	3.114	-	**-3.967**	**-6.352**	-
RT4	**12.186**	**10.264**	-	-0.245	**-4.180**	-
RT5	**9.133**	**8.342**	-	0.728	-1.088	-
	1997					
RT1	**17.135**	**10.321**	-	**11.509**	**10.691**	-
RT2	**10.174**	**6.964**	-	**9.328**	**12.113**	-
RT3	**8.529**	**6.878**	-	2.085	0.756	-
RT4	**12.741**	**7.248**	-	**4.187**	**2.535**	-
RT5	**5.620**	1.519	-	-0.054	-0.440	-
	changes					
RT1	3.052	-0.735	-	**4.943**	**8.960**	-
RT2	-2.892	-3.877	-	**4.987**	**9.248**	-
RT3	**7.067**	3.765	-	**6.052**	**7.108**	-
RT4	0.555	-3.016	-	**4.432**	**6.715**	-
RT5	-3.513	-6.823	-	-0.782	0.648	-

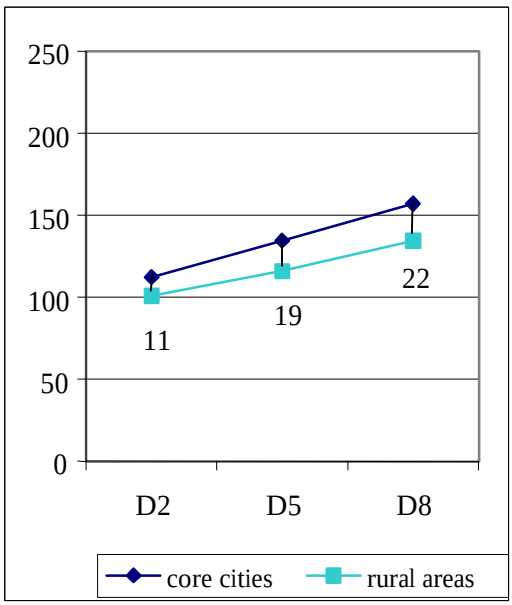
Notes: Coefficients at least significant at the 5% level in bold types.

Table8: **Regression results for the agglomeration wage differential**

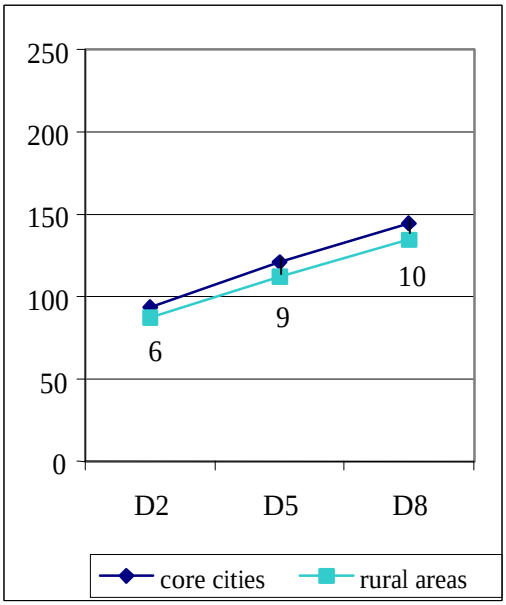
Independent variables	Dependent variable: log (agglomeration wage differential +100)			
	All (1)	Manu-facturing (2)	Services (3)	All (4)
constant	**4.538** (0.013)	**4.512** (0.014)	**4.563** (0.020)	**4.538** (0.012)
log population density	**2.522** (0.261)	**3.252** 0.282	**1.792** 0.382	**1.988** (0.259)
D5	-	-	-	0.007 (0.129)
D8	-	-	-	**0.341** (0.151)
skilled workers	-	-	-	**0.372** (0.129)
high-skilled workers	-	-	-	**0.263** (0.151)
Manufacturing	-	-	-	**0.482** (0.112)
N	96	48	48	96
R^2	0.492	0.737	0.309	0.610

Notes: Standard error in parentheses below the coefficients; at least at the 5%-level statistically significant coefficients in bold types; all coefficients with exception of standard errors are multiplied by factor 100; D5 (D8): median (eighth decile); *N*: Number of cases; R^2: adjusted coefficient of determination. Column (2) and (3): results only for Manufacturing and Services, respectively.

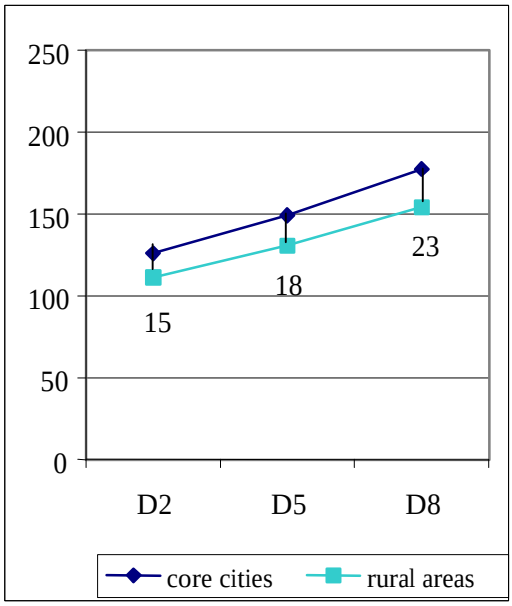
Figure 1:
Wage differential between core cities and rural areas for low skilled workers by sector and decile of wage distribution for 1985 and 1997 (in DM of 1995)



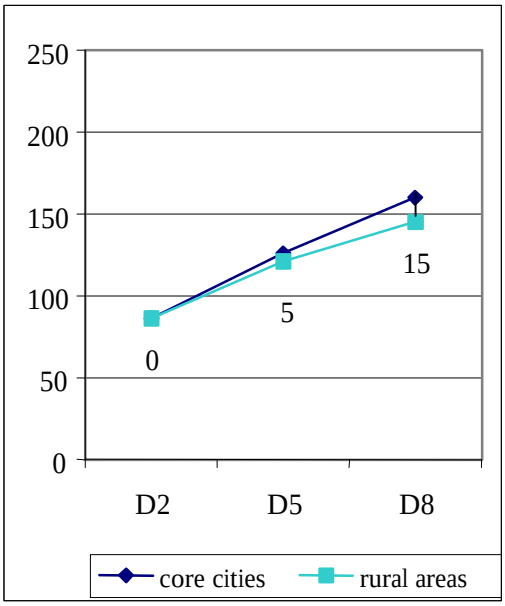
Manufacturing 1985



Services 1985

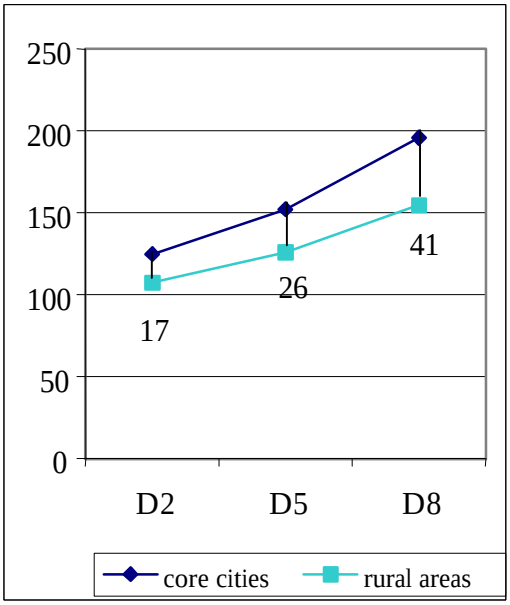


Manufacturing 1997

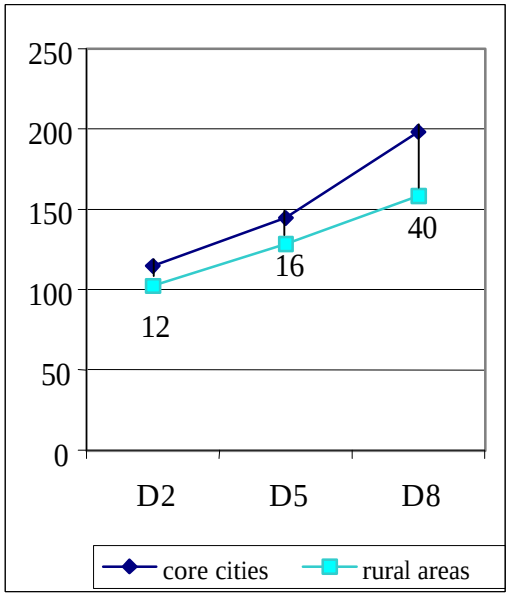


Services 1997

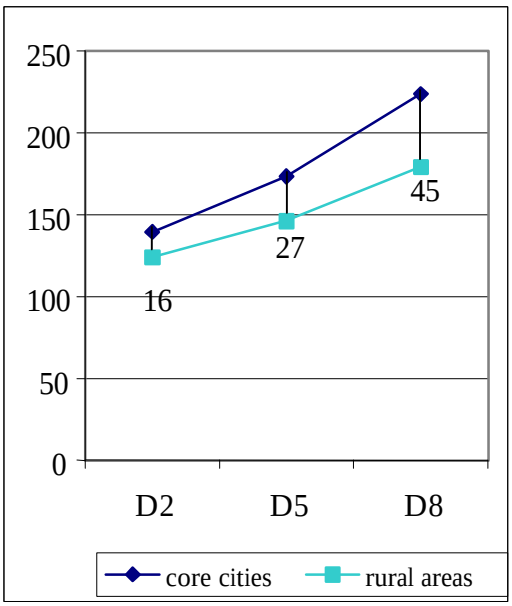
Figure 2:
Wage differential between core cities and rural areas for skilled workers by sector and decile of wage distribution for 1985 and 1997 (in DM of 1995)



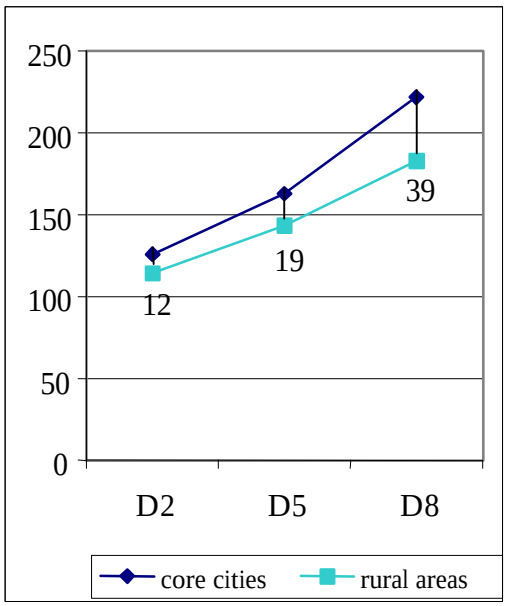
Manufacturing 1985



Services 1985

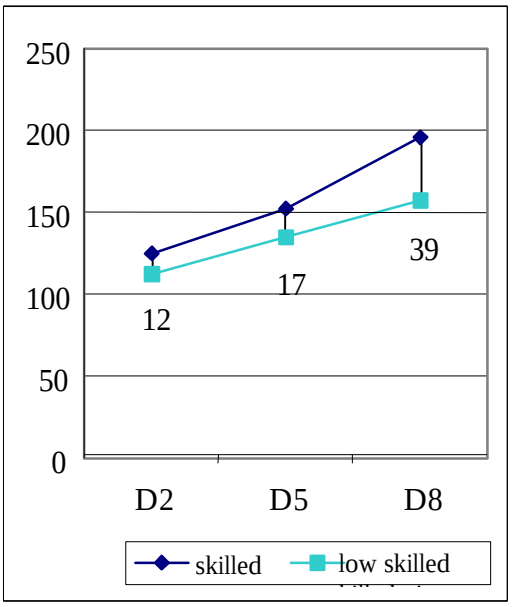


Manufacturing 1997

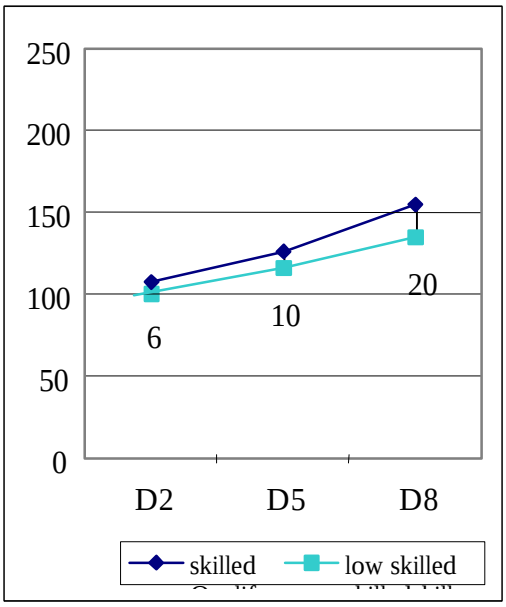


Services 1997

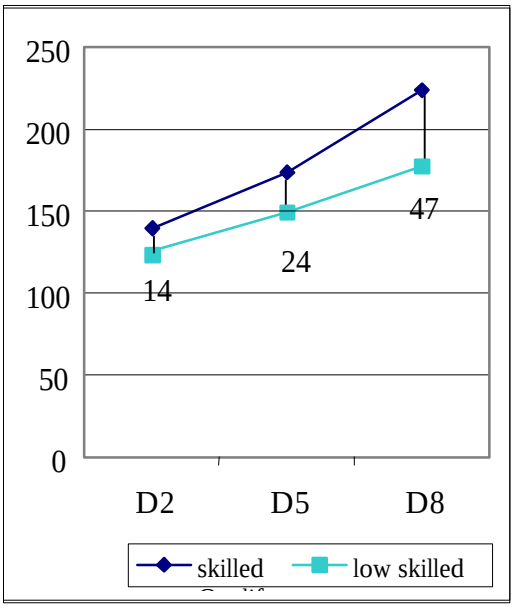
Figure 3:
Real wages of low-skilled and skilled workers in the manufacturing sector by type of the region and decile of the wage distribution 1985 and 1997 (in DM of 1995)



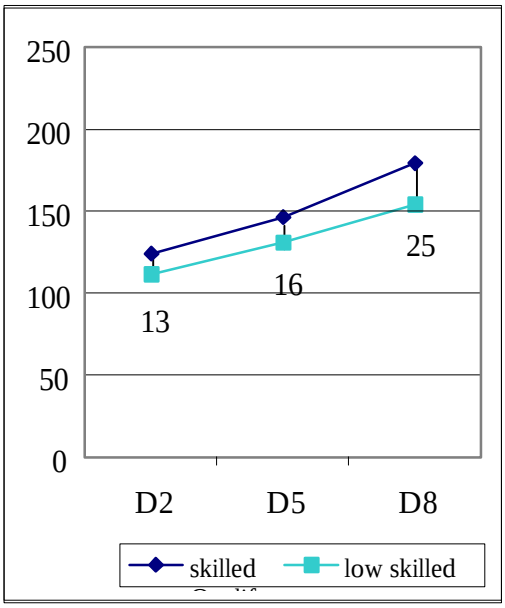
core cities 1985



rural areas 1985

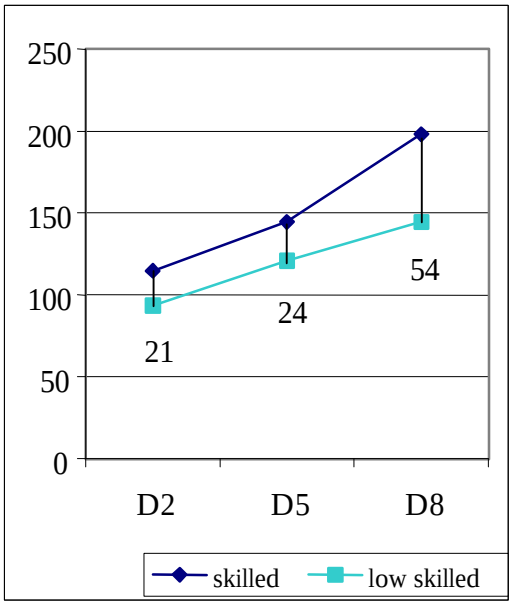


core cities 1997

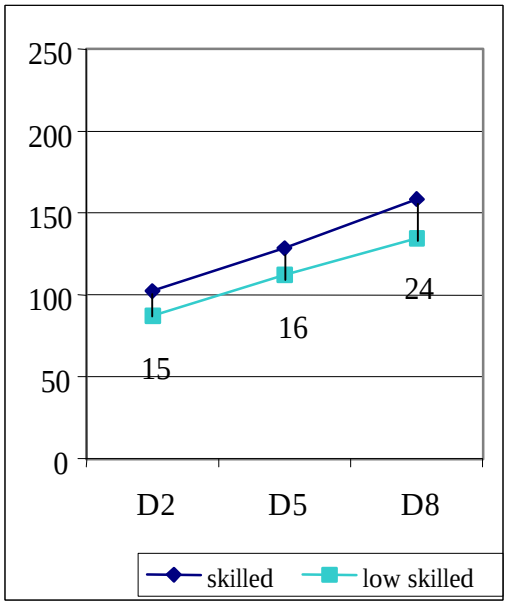


rural areas 1997

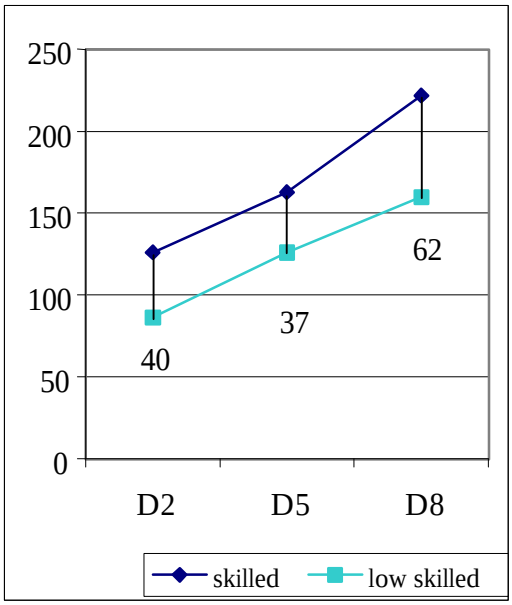
Figure 4:
Real wages of low skilled and skilled workers in absolute values for services by type of the region and decile of the wage distribution
1985 and 1997 (in DM of 1995)



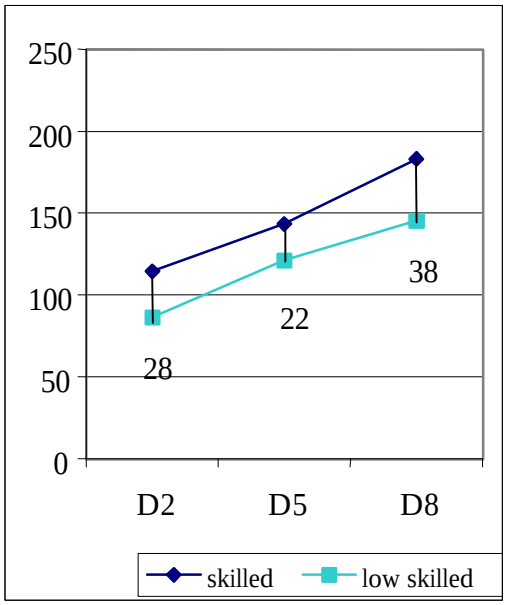
core cities 1985



rural areas 1985



core cities 1997



rural areas 1997

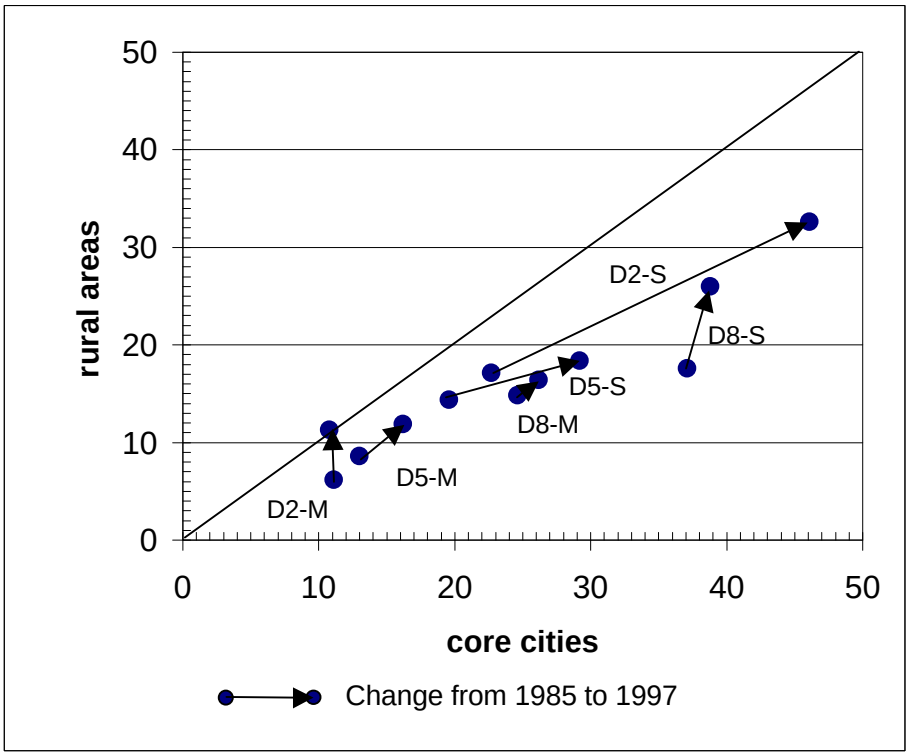



Figure 5:
Skill premium of skilled versus low-skilled workers in percent 1985 and 1997 in core cities and rural areas for the manufactuing (M) and service sector (S) (by decile of the wage distribution)