

Büttner, Thiess

Working Paper

Local wages and sectoral wage bargaining in Germany

Diskussionspapier, No. 30

Provided in Cooperation with:

Department of Economics, University of Konstanz

Suggested Citation: Büttner, Thiess (1995) : Local wages and sectoral wage bargaining in Germany, Diskussionspapier, No. 30, Universität Konstanz, Forschungsschwerpunkt Internationale Arbeitsmarktforschung, Konstanz

This Version is available at:

<https://hdl.handle.net/10419/92453>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

Forschungsschwerpunkt
"Internationale Arbeitsmarktforschung"

Center for International Labor Economics
(CILE)

Fakultät für Wirtschaftswissenschaften und Statistik
Universität Konstanz

Thiess Büttner

Local Wages and Sectoral
Wage Bargaining in Germany

0 8. JAN. 1996 Weltwirtschaft
W 752 (30) mi gu sig gla

Postfach 5560 D 139
78434 Konstanz
Deutschland / Germany

Diskussionspapier
30 – 1995

Local Wages and Sectoral Wage Bargaining in Germany

Thiess Büttner

W 752 (30)



649633

Diskussionspapier

Nr. 30

Dezember 1995

Abstract

The peculiarities of the German system of labor relations suggest, that the efficiency wage hypothesis stating an inverse relation between local wages and local unemployment should be related to sectoral wage bargaining on the national level. For that purpose a theoretical model is presented which relates firm specific wages with wage negotiations on a supra-firm level. It is shown that there exists a reasonable bargaining scheme which supports an aggregate wage gap. The model shows a particular nonlinearity of the wage curve, which suggests that there is no influence of unemployment in low wage / high unemployment regions. In the empirical section a wage curve estimation using aggregate data is presented. Although the combined explanation with efficiency and negotiated wages cannot be tested directly, some supporting results are found.

1 Introduction

Differences in local labor market conditions in particular the dispersion in unemployment rates and in wages are an often discussed phenomenon in Germany. However, probably with the exception of the case of the New-Laender there is still no broad consensus among economists how to assess these differences.² One of the major issues in this context is the question if a rigidity in the spatial wage structure causes the differences in unemployment rates. This paper discusses the flexibility of the spatial wage structure in Germany both theoretically and empirically. It tries to relate the wage curve hypothesis, which has been put forward in particular by Blanchflower / Oswald (1990, 1994), to sectoral wage bargaining which is predominant in Germany.

Before discussing the relation between local labor market conditions and local wages in a formal setup, let me briefly ask for relevant hypotheses in the case of Germany. Neglecting the hypothesis that labor is traded on local walrasian markets, an explanation of the influence of local employment conditions on the local wages could be offered by assuming that the wage is the outcome of a bargaining between the employer and its employees. The expected opportunity wage reflecting the local labor market conditions could then influence the bargaining outcome. With employers and employees being assembled in large coalitions, the bargaining in the German labor markets is located mainly on a supra-firm level. Since there is a vast number of contracts between federations of employers and unions in Germany³ prescribing the wage and working conditions for all kinds of occupations, branches, and regions, it is a difficult task to assess to what degree the contracts differ locally. Recently Bispinck et al. (1995) have published an investigation into the structure of the German labor agreements. They compared major agreements, which cover some 11.7 Million employees in the Old Laender of the Federal Republic of Germany.⁴ Table 1 resembles specifics of contracts listed in the study of Bispinck et al. (1995),⁵ which were effective in the end of 1992. For most sectors there are distinct agreements for blue (wage agreement) and white collar workers (salary agreement). Some sectors have only one agreement which is referred to here as a remuneration contract. In column three the numbers of employees subject to the contracts are listed. According to column four, in most cases which could be assessed all of these employees are used in the evaluation. The mean monthly basic payment ("Grundvergütung") in a medium skill category for workers with longest tenure and highest age ("Endstufe") is listed in column five.

¹I would like to thank Bernd Fitzenberger, Werner Smolny and Peter Winker for comments and criticism.

²cf.: Sachverständigenrat (1994) and (1993).

³In 1994 there were nearly 38.000 contracts enforced in Germany's Old Laender. cf. WSI (1995).

⁴This amounts to 60 % of all employees who are subject to labor agreements with one of the unions which form the Deutsche Gewerkschafts Bund (DGB).

⁵Sectors with less than 100.000 employees are neglected.

The spatial differentiation is documented in the last four columns. For nearly a third (3,8 Million) of the employees there is no spatial differentiation at all (Public Services, Building Industry Proper, Banking and others). The negotiated basic wage shows very little differentiation for the blue collars in Metal Industry and for the white collars in Retail Trade, which also is roughly a third (together 3.800 thousand employees). As a reference, note that the variation coefficients of actually paid wages in the manufacturing industry, is about 0.14 for the 327 counties of the Old Laender at the end of the eighties.⁶ However the comparability is weak, since Table 1 shows a more differentiated sectoral structure.

Finally there is the last third of the listed labor agreements, which shows more regional heterogeneity. The largest relative span (74.4 %) is reported for the salary agreement in Private Transport, however, the standard deviation is still small relative to the mean, the variation coefficient is 0.0573. Moreover, according to the last column the differentiation is mostly on a state level. Yet, according to Bispinck et al. (1995) there are still some contracts which show a spatial differentiation inside of a spatial unit.⁷

For some sectors (Hotels and catering, Priv. Transport, Textile, Wood Processing, Cleaning and Clothing) an evaluation could not be done because of noncomparable definition of skill categories. This might introduce a selection bias. But since these sectors employ 1.2 Million which is one tenth of all listed sectors, the bias can't be important. There are two further problems for the interpretation of the listed contracts. First, there is no control for the location pattern of an industry. If an industry is heavily concentrated, a low spatial differentiation should be interpreted differently to an evenly distributed industry. For this reason the Coal as well as the Iron & Steel industries have been omitted. The second problem is even more difficult. A significant degree of spatial differentiation could be achieved if employers could choose how a particular job is classified according to the contract. Being hard to tell how important this flexibility by classification is, one can only suggest that the unions are trying hard to make the employers refrain from doing so.

However, taking the numbers as they are, the statement can be made, that the coalition bargaining in Germany at least in important sectors does not account for local labor market conditions to a significant degree. It should be justifiable to make the working assumption, that the sectoral wage negotiations are in a way orthogonal to the local labor market conditions. This view can be supported, either theoretically by giving reasons for efficiency gains in a spatially inflexible wage rate,⁸ or by pointing to the solidarity principle.⁹

Besides the labor agreements local labor market conditions may affect the wages

⁶The figures for the industry wages as used in the empirical section below are: 0.1407 (1987), 0.1409 (1988), 0.1406 (1989) and 0.1378 (1990).

⁷Those contracts build classes of locations, which may differ with respect to payments ("Ortsklassen").

⁸cf. Burda / Mertens (1994) for a reason based on an implicit contract argument.

⁹cf. Paque(1993), p.24

Table 1: Spatial differentiation of sectoral wage agreements

sector	kind of agreement ^{a)}	number of subjected employees (in 1000)	coverage	mean payment (DM) ^{b)}	Standard deviation ^{c)}	Coef. of variation ^{d)}	relative span (in%)	spatial units
Metal Industry	wage	2310.6	1	2614.5	2.2	0.0008	0.3	15
	salary	1311.3	1	3099.7	197.4	0.0637	44.0	
Public Service	wage	756.2	1	3174.0	0	0	0	1
	salary	1539.6	1	3091.0	0	0	0	
Retail Trade	wage	353.9	1	3187.6	233.7	0.0733	9.6	12
	salary	1440.2	1	2817.6	9.3	0.0033	0.2	
Building Industry Proper	wage	759.0	1	3439.0	0	0	0	1
	salary	157.7	1	3462.0	0	0	0	
Chemical Industry	remun.	723.3	1	3708.0	66.9	-0.0180	5.8	12
Hotels and Catering	remun.	513.0	.	.	.	.	.	13
Priv. Transport	wage	420.0	.	.	.	.	.	12
	salary	137.3	.	2955.8	169.4	0.0573	74.4	
Banking	remun.	380.0	1	3592.0	0	0	0	1
Repair of Vehicles	wage	213.4	1	2811.0	129.4	0.0460	29.2	14
	salary	70.3	1	3022.2	207.5	0.0687	23.8	
Priv. Insurance	remun.	268.0	1	3551.0	0	0	0	1
Textile Industry	wage	128.4	0.85	2526.5	61.3	0.0243	7.6	10
	salary	35.4	.	.	.	.	.
Wood Processing Industry	wage	143.8	0.97	2890.6	114.3	0.0395	15.3	13
	salary	45.9	.	.	.	.	.
Printing Industry	wage	130.1	1	3364.0	0	0	0	9
	salary	55.1	1	3319.9	154.5	0.0465	16.9	
Cleaning (buildings)	wage	140.9	.	.	.	.	.	11
	salary	15.1	.	.	.	.	.
Iron and Steel	wage	110.5	.	.	.	.	.	5
	salary	39.2	.	.	.	.	.
Coal Mining	wage	99.5	.	.	.	.	.	4
	salary	23.9	.	.	.	.	.
Clothing Industry	wage	120.5	0.98	2260.2	31.6	0.0140	9.6	12
	salary	35.4	1	.	.	.	.
Energy	remun.	121.7	1	3917.3	164.1	0.0419	13.4	8
Paper Processing Industry	wage	78.1	1	2760.0	0	.	0	9
	salary	25.0	0.84	3216.8	126.2	0.0392	22.5	

Source: Bispinck et al. (1995). ^{b)} and ^{c)} are own calculations based on Bispinck et al. (1995).

^{a)} "wage" denotes agreements only for blue collar, "salary" only for white collar workers, "remuneration" stands for agreements which cover both.

^{b)} basic payment for a medium skill worker. The numbers of individual agreements are weighted with the employees covered.

^{c)} Standard deviation of the mean payment.

^{d)} Standard deviation divided by the mean payment.

because individual employers deviate from the negotiated wage. Namely, given the negotiated wage, an employer might find that in order to acquire and to hold a stock of qualified and motivated employees it would be necessary to pay a higher wage. It is, indeed, a characteristic of labor relations in Germany that wages effectively paid are often higher than negotiated wages.¹⁰ Yet, the size of the resulting wage gap is difficult to measure.

In general, it seems reasonable to assume, that the employer fixes the wage subject to restrictions which are set by the bargaining between the coalitions. Although these restrictions are covering not only wages for different occupational categories but also regulations on working time and all other aspects of working conditions, the following discussion focuses on the wage. In order to use an approach combining a structure of firm specific optimal wages with union activity as an explanation for spatial wage formation, one has first to explain why and when employers might pay more than the negotiated wage. Moreover, one has to show that there is a reasonable wage setting or bargaining scheme on the supra-firm level, which is not only consistent with a wage gap, but which could also support a constant aggregate wage gap in the long run, which is a stylized fact in the German labor market.¹¹ After having presented the theoretical model of wage formation in the next section, the implications for the local wage structure are discussed. An empirical investigation of the spatial wage structure follows in the last section. Although the combined hypothesis of wage bargaining and the wage gap cannot be tested directly, in the preliminary empirical analysis some supporting results will be presented.

2 A theoretical model of wage formation

To explain why it might be advantageous to pay higher wages is, of course, a matter which is discussed in incentive wage models. In the beginning of this section a turnover model is used to describe individual wage setting.¹² Then the behaviour under the restriction of union wages is analysed and finally the solution of a monopoly union model is discussed.

¹⁰Schnabel (1995) finds numbers between 5 % and 15 %.

¹¹see Möller (1991) and Schnabel (1995) for an estimation of the long run wage gap.

¹²cf. Schlicht (1978) and Salop(1979), for a recent reference cf. Phelps(1994).

2.1 The wage curve

The profit of an employer is defined by the value of production less wage and capital costs, which may be formalized as follows:

$$\Pi_i = p_i (F_i) F_i \left(\underbrace{e_i(h_i) E_i}_{L_i}, K_i \right) - w_i E_i - r_i K_i \quad (1)$$

- p_i : price of output
- E_i : physical employment
- L_i : employment in efficiency units
- e_i : average efficiency of employees
- F_i : production function
- w_i : the firms wage
- h_i : hire rate
- K_i : stock of capital
- r_i : rental rate

The term $e_i(h_i)$ ($e'_i < 0$) translates labor from physical to efficiency units, and thereby acts like an effort function. However, it is assumed dependent on the hire rate: If the ratio of trainees to total employees (i.e. the hire rate) rises, the efficiency of employed labor decreases. This reflects the lower productivity of trainees, such that training costs consist of foregone output.

If there are no hires, the stock of employees decreases since there are always quits. The quit rate q_i is assumed to be a zero homogenous function with the firms wage, the expected opportunity wage and the income from wealth or transfers as arguments. The zero homogeneity assumption reflects the relativity in the valuation of wages.¹³

$$q_i = q_i(w_i, (1 - u) w_{-i}, y^w) \quad (2)$$

- w_{-i} : average local wage excluding firm i
- u : rate of unemployment
- y^w : wealth and transfer income

It is assumed in the following a kind of Nash-conjecture that wages of the other firms are not affected by the wage setting of the individual employer.

Due to the training costs hiring of employees is a kind of investment which pays off over time. Therefore the appropriate framework of analysis is a dynamic one. It could be assumed that the present value of profits is maximized by choosing a wage and a hiring

¹³see Phelps (1994) for a discussion of different assumptions concerning the quit rate function.

rate, subject to the condition that the growth rate of the stock of employees is given by the hire and quit rates. One might ask, if a labor supply restriction must be introduced. Indeed, it is assumed that there is always some queueing for each job. As Schlicht (1994) has pointed out, this does not necessarily imply that there is unemployment, since employees could search on the job.

As is shown in the appendix by employing the suggested dynamic approach we end up with a slightly modified version of Solow's elasticity condition.¹⁴ The elasticity condition, however, can much more simply be derived if we follow Salop (1979), and assume that the hire rate is chosen such that the stock of employees is constant, i.e. the firm is already in its steady state.

The firm then maximizes the profit Π_i subject to the constraint that hire and quit rate are equal ($h_i = q_i$). By differentiation with respect to wages and employment:

$$p_i \left(1 - \frac{1}{\phi_i}\right) \frac{\partial F_i}{\partial L_i} \frac{\partial e_i}{\partial h_i} \frac{\partial q_i}{\partial w_i} \stackrel{!}{=} 1 \quad (3)$$

$$p_i \left(1 - \frac{1}{\phi_i}\right) \frac{\partial F_i}{\partial L_i} e_i \stackrel{!}{=} w \quad (4)$$

The first condition states, that the wage is optimal at a level where the increase in direct wage costs is exactly offset by the gain from reduced quits, the second condition equates the value of marginal product of an employee to the wage rate. Using both equations the elasticity condition can be obtained as:

$$1 = \frac{\partial \ln e_i}{\partial \ln h_i} \frac{\partial \ln q_i}{\partial \ln w_i} \quad (5)$$

Provided a unique solution exists,¹⁵ this condition implies an equilibrium quit rate and thereby a negative relation between the wage and the unemployment rate. Using the zero homogeneity assumption on the quit rate function one might suggest a simple functional form:

$$q_i = \left(\frac{(1-u) w_{-i}}{w_i} \right)^{\alpha_i} \left(\frac{y^w}{w_i} \right)^{\beta_i} \quad \alpha_i, \beta_i > 0$$

Now the optimal wage condition can be used to formulate the wage curve:

$$\ln w_i = \delta_{0i} + \delta_{1i} \ln(1-u) + \delta_{1i} \ln w_{-i} + \delta_{2i} \ln y^w \quad (6)$$

¹⁴cf. Solow (1979).

¹⁵Technically speaking, some condition must ensure that the right hand side of the Solow condition (5) crosses unity from above with an increasing wage rate. Salop (1979) and Phelps (1994) ensure the existence by assuming a separate concave training costs function, such that the costs of training are not explained by foregone output. For the constant elasticity quit rate function as employed below, a reasonable sufficient assumption is that the efficiency $e_i(q_i)$ is a linear function of the ratio of trained to employed personnel: $e_i(q_i) = e_{o,i}(1 - q_i)$. This assumption also guarantees monotonous behaviour of the right hand side of (5).

$$\delta_{1i} = \frac{\alpha_i}{\alpha_i + \beta_i}$$

$$\delta_{2i} = \frac{\beta_i}{\alpha_i + \beta_i}$$

The elasticities with respect to the average wage of other employers and the employment rate (δ_{1i}), and other income (δ_{2i}) are all positive and less than one.

If there are differences in the willingness to quit or in training costs or in other factors determining the wage curve between firms, this firm specific wage curve may give rise to a wage differential. As long as there is some queueing for each job offered, firms are not forced to equalize wages.¹⁶

Upon this individual wage formation, let us now introduce union activity on a supra-firm level.

2.2 Union activity on a supra-firm level

Suppose that there are coalitions of workers and employers on a supra-firm level which negotiate on a minimum wage rate. Since the employees are working in different firms, the minimum wage is either above or below the firmspecific optimal wage as defined by equation (6). If it is below, the employer is expected to pay just the minimum wage, else the optimal wage is paid. In all other aspects each employer has the right to manage, thereby all the other topics of negotiations are excluded from the analysis and the hire rate as well as the employment is chosen freely. As has been suggested in the introduction, although this view is quite a rough abstraction it is related to the German case.¹⁷

For the behaviour of both, the employers coalition and the union, it is important how the individual firm behaves under the restriction of a prescribed minimum wage. Therefore let me start with a view on that behaviour.

2.2.1 The effect of the negotiated wage on the individual firm

An influence of the negotiated wage is possible either by restricting the firms wage setting directly or by altering the opportunity set of employed workers. But whereas the nonrestricted firm may react with the wage along its wage curve and does not change its employment decision, the restricted firm is pulled away from its wage curve and reacts with employment. This can be derived formally by adding a side condition

¹⁶cf. Schlicht (1978) and Salop (1979).

¹⁷For the view of the negotiated wage as a minimum wage in the German context cf. Kleinhueckelskoten /Spaetling (1980) and Schnabel (1995).

to the above optimization problem of the firm; the objective function becomes:

$$\Lambda_i = \Pi_i + \omega_i (w_i - w^T)$$

Where Π_i is the profit as defined above and ω_i is the shadow price. In the observed optimum the following conditions will hold:

$$\frac{\partial \Pi_i}{\partial w_i} + \omega_i \leq 0 \quad \text{with equality if } w_i - w^T > 0 \quad (7)$$

$$\frac{\partial \Pi_i}{\partial E_i} = 0 \quad (8)$$

$$w_i - w^T \geq 0 \quad \text{with equality if } \omega_i > 0 \quad (9)$$

Only the condition for the optimum wage has changed. The shadow price describes how the profit is affected by the restriction. Using the above derivations one can obtain:

$$\frac{\partial \Lambda_i}{\partial w^T} = -\omega_i = -\left(1 - \frac{\partial \ln e_i}{\partial \ln w_i}\right) E_i \quad (10)$$

For a restricted firm the impact of w^T is zero, since the Solow-condition (5) is fulfilled. If the firm is forced to pay a higher wage the elasticity of efficiency is driven below unity. Therefore an increase in the negotiated wage has a harmful effect on the firms objective function.

Since the opportunity set of its workers may change, the decisions of restricted firms are also influenced by the wage setting of other firms, such that there is some complexity. If it could be assumed, that the firms face different segments of the labor markets, they would not influence the opportunity wages of each others employees. Then, the optimal wage of a nonrestricted firm would not be affected by the negotiated wage, and the analysis would be simplified. Fortunately, since the goal is to discuss the spatial wage response, we could assume each firm of a sector to be located in a different spatial segment of the labor market. Given our working assumption of an orthogonality of sectoral and local wage formation, this assumption provides us with an interesting benchmark case. Let me turn therefore to the simple case, where there aren't any wage spillovers, i.e. where the wage of a nonrestricted firm is unchanged.

If a production function of Cobb-Douglas is supposed, where γ_i denotes the production elasticity of labor in efficiency units, the employment elasticity for an exogenous rental rate r can be derived from the firms optimality conditions¹⁸:

$$\eta_{E_i, w^T} = [\gamma_i \phi_i + (1 - \gamma_i)] \left(1 - \frac{\partial \log e_i}{\partial \log w^i}\right) + \frac{\partial \log e_i}{\partial \log w^i}$$

for: $w_i^* \leq w^T$

w^T : negotiated wage in firm i's sector

¹⁸These are the equality of the marginal value product of capital ($p_i \left(1 - \frac{1}{\phi_i}\right) \frac{\partial F_i}{\partial K_i} \stackrel{!}{=} r$) as well as (4).

If a restricted firm is very close to its wage curve the first term drops out and the second term is unity since the Solow-condition is fulfilled. If the firm is forced to pay a higher wage, the elasticity condition is driven down. In the limit the elasticity approaches the term in square brackets which is larger than one. Therefore, the elasticity of the labor demand of a restricted firm is strictly increasing with the prescribed wage.

Now let me turn to the issue how the negotiations can be described.

2.2.2 Negotiations on a supra-firm level

Suppose there are negotiations between a coalition of employers in a sector and a union which represents their workers. If the coalition of employers aims to maximize the return to capital of its members and the union tries to maximize a utility function with the sectoral wage and the employment as arguments, the negotiated wage could be determined using a Nash bargaining solution. Whereas the fallback level of the unions will be determined by the sectoral wage and the employment without restricting any firms wage setting, the fallback level of the employers will be the rental rate on alternative investments. For simplicity I will assume, that the employers are always at its fallback level, such that they earn a rental rate r and the bargaining is analogous to the case of a monopoly union, which sets the wage and leaves the right to manage to the employers.

The union utility is described by a functional form of Stone Geary type. It is not only a relatively general functional form¹⁹, it also has a zero homogeneity assumption where the union utility is not affected by uniform changes of all wages in the economy. Moreover its logarithmic structure allows a relative easy handling.

In order to make the analysis transparent, let there be a continuous function describing the density of the optimum wages, such that the share of employees getting a wage below the negotiated wage w^T can be written as: $\int_0^{w^T} a(w^*) dw^*$

Then the sectoral unions utility function is:

$$V(w^T) = \underbrace{\left[\int_0^{w^T} a(w^*) \ln \left(\frac{w^T}{w^*} \right) dw^* \right]}_{\text{wage target}}^\Theta \underbrace{\left[\int_0^\infty a(w^*) \ln E(w^T, w^*) dw^* \right]}_{\text{employment target}}^{1-\Theta} \quad (11)$$

$E(w^T, w^*)$ denotes the employment of firms paying an optimum wage of w^* and facing a restriction of w^T . According to the functional form the union values the wage and employment effect of the negotiations separately. The wage target is the gain with respect to the optimal wage averaged over the restricted firms. Since there is no effect on the wages of nonrestricted firms, these drop out. The employment target is an average of firms employment. The weights in averaging are the employment shares of

¹⁹ A discussion of functional forms of union utility functions can be found by Farber (1986), p. 1061

the nonrestricted firms $a(w^*)$.

How does this function change with the level of the negotiated wage? Logarithmic differentiation yields:

$$\frac{\partial \ln V}{\partial \ln w^T} = \Theta \frac{\int_0^{w^T} a(w^*) dw^*}{\int_0^{w^T} a(w^*) \ln \left(\frac{w^T}{w^*} \right) dw^*} - (1 - \Theta) \frac{\int_0^{w^T} a(w^*) \eta_{E, w^T} dw^*}{\int_0^\infty a(w^*) \ln E(w^T, w^*) dw^*} \quad (12)$$

A solution exists, if the relative increase in the wage target (first term) is approaching zero with increases in the negotiated wage, provided that the relative loss in the employment target (second term) is ever increasing. Since the first term is the inverse of the average wage gap in the restricted firms it goes towards zero for high negotiated wages. The second term is simply the average employment elasticity of restricted firms divided by the average employment. This term is always increasing. By setting the change in union utility to zero, the following solution is found.

$$\ln w^T - \frac{\int_0^{w^T} a(w^*) \ln w^* dw^*}{\int_0^{w^T} a(w^*) dw^*} = \frac{\Theta}{1 - \Theta} \frac{\int_0^\infty a(w^*) \ln E(w^*, w^T) dw^*}{\int_0^{w^T} a(w^*) \eta_{E, w^T} dw^*} \quad (13)$$

It expresses that the span between the negotiated wage and the average optimal wages of restricted firms is larger, the smaller the average employment elasticity, the larger the average employment and the larger the weight of wages in union utility, which are quite standard results. Further results could be given if the left censored distribution of optimal wages were known.

What can be deduced for the evolution of the wage in an aggregate economy? Suppose all wages in the economy but outside of the sector under consideration would change by factor μ . If the wealth income also changes by this factor, or the weight of wealth income in the quit rate function is small, we can deduce from the wage curve, that the optimal wages inside the sector will also change by that factor. Now, if also the prices change by factor μ thereby leaving the perceived demand elasticities ϕ constant, also the employment decisions and the profits are unchanged. The union utility is unaffected if also the negotiated wage increases by μ such that the wage gap remains constant. Therefore, in the long run an exogenous increase for example of the labor productivity in all sectors will not change the aggregate wage gap. But if we assume a nationwide increase in the unemployment rate, we can deduce a reduction in the aggregate wage gap.

The solution of the bargaining has been obtained without a modelling of the target function of the employers. This could be done similarly, but there is the specific problem of membership in the employers coalition. Why doesn't an employer leave the coalition if he feels restricted by the agreements? This issue has been dealt with in the discussions on the centralization of wage bargaining.²⁰ With respect to the German case one answer

²⁰cf. Calmfors / Drifill (1988)

is, that an employer leaving the coalition becomes the counterpart of negotiations and stands alone against the union.²¹ Leaving the coalition can therefore be detrimental to the employer, all the more he might be forced to pay higher wages. However, each increase in the negotiated wage increases the pressure on the restricted firms to leave the coalition.²²

With this theoretical background let us now come back to the question addressed in the beginning section, how local conditions affect the local wage rates.

2.3 Local wages under sectoral wage bargaining

Following our working assumption, for each sector there is a wage bargain, prescribing the negotiated wage equally to all local labor markets. Let us assume for simplicity that all firms of a sector have equal optimum wages at a single locality. The local wage level can then be defined as an average of sectoral negotiated wages and sectoral optimum wages. The local wage level in region r is defined as:

$$w_r = \sum_{s=1}^S a_{s,r} b_{s,r} w_s^T + \sum_{s=1}^S a_{s,r} (1 - b_{s,r}) w_{s,r}^* \quad (14)$$

$a_{s,r}$: share of sector s in the local employment

$$b_{s,r} = \begin{cases} 1 & w_{s,r}^* \leq w_{s,r}^T \\ 0 & w_{s,r}^* > w_{s,r}^T \end{cases}$$

The local labor market conditions will enter the local wage level via two effects. The optimal wages are affected according to the sector specific wage curve $w_{s,r}^*$. But also the index variable b_s is affected. The relation between the local labor market conditions and the wage level therefore is clearly nonlinear. If the local rate of unemployment is high in relation to other regions, the optimal wages tend to be below the negotiated minimum wages. Therefore a larger share of local firms pay the minimum wage and the effect of unemployment on the wage level is rather low.

A nonlinear relation between the local wage level and the local rate of unemployment is a regular result in the theoretical (and empirical) analysis of the wage curve. In comparison to the usual explanation of the nonlinearity as resulting from the probability of the unemployed getting a job²³ in this framework it stems from the interaction of

²¹ see Franz (1995) for a discussion of advantages and disadvantages of negotiating on a supra-firm level in view of the German case.

²² Another related issue is the question why employees are union members also in firms, which pay wages above the minimum wage. Although this question is important for the unions, due to the regularities on the German labor markets where nearly all employees are subject to union-employer negotiations it is not that important in the present context.

²³ This is self evident with respect to the efficiency wage foundation of the wage curve. Blanchflower / Oswald (1990,1994) also use a bargaining framework to explain the wage curve, where a nonlinearity

sectoral negotiations and individual wage setting. Although it should be difficult to distinguish these explanations empirically, the conclusions drawn with respect to the flexibility of the spatial wage structure can be quite different.

A strict explanation of the spatial wage structure along the lines of the theoretical argument requires knowledge of the index variables b_s for each sector in a locality. Due to the lack of data the explicit modelling of the index variables could not be done in the following section. Instead of estimating equation (14) an attempt is made to estimate the following relationship:

$$w_r = w \left(\sum_{s=1}^S a_{s,r} w_s^T, w^*(u_r, w_{-r}), u_r \right) \quad (15)$$

The local wage rate is therefore related to an average of sectoral negotiated wages relevant in the location as well as to the local employment conditions which drive the wage curve. The additional influence of the unemployment rate shall mirror the effect of the index variables.

3 A view on the spatial wage structure

For the German case there already exist studies which discuss the empirical relationship between local wages and local unemployment. Blien(1995) entails an overview of both findings and methods. As these studies are mainly concerned with the wage curve hypothesis which has been put forward in particular by Blanchflower / Oswald (1990,1994) they use individual data,²⁴ where other dimensions of the wage structure, such as age, sex and qualification can be controlled for. In comparison the present analysis is based on aggregate wage data. The unobserved heterogeneity can hopefully be controlled for by using the local sectoral composition of employment, by introducing spatial contiguity, by estimating in differences and by using fixed effects. In the next section a short description of the data is given, before the estimation of a wage curve is presented. The estimated wage curve is then analysed further, to test if the combined local and sectoral wage hypothesis as presented in the theoretical section is supported by the data.

also stems from the probability to find a job. cf. Blanchflower / Oswald (1990), p. 222 and Blanchflower / Oswald (1994), p.85

²⁴An exception is Schwarze (1995) which gives some evidence for the wage curve hypothesis in Germany using aggregate industry wages for 75 regions in Germany.

3.1 The data

The database consists of regional and/or sectoral data for four years (1987-1990), for 30 manufacturing sectors, and for the 327 counties²⁵ of Germany's Old Laender.²⁶ Let me give a short description of the individual series (r indicates the county, s the sector, and t the time period)²⁷

$w_{r,t}$ (**local wages**) The local wages are the average annual payments per employee in the manufacturing industry.

$w_{r,t}^T = \sum_{s=1}^S \alpha_{s,r,t} w_{s,t}^T$ (**average of national wages**) As a proxy for the negotiated wages in the sectors the effective national sectoral wages are used since negotiated wages are not available in levels. The problem arises, that this variable contains the national average wage gap. Since this will be constant in the long run, the usage of the national wages is in line with the theoretical argument which suggests an equilibrium wage gap. With respect to short run dynamics, however, the interpretation as a proxy for negotiated wages is difficult. But by introducing this variable it can be controlled for the sectoral (effective) wage structure. The local employment shares of 30 industrial sectors are taken from the social security data.

$u_{r,t}$ (**local unemployment rate**) The unemployment rate is calculated as the number of registered unemployed divided by the population at working age (15 to 65 years of age).

$h_{r,t}$ (**average hours per worker**) To control for working time average hours per worker in the manufacturing industry is included.

W (**spatial weight matrix**) To allow for spatial interaction a digitized map of boundaries has been used to construct a 327×327 weight matrix. If county i has a common boundary with county j $w_{i,j}$ gives its share in the total boundary length of i .²⁸

3.2 Estimations and results

The central variables in this study, i.e. the local wage level ($w_{r,t}$), the local average negotiated wage ($w_{r,t}^T$) and the local unemployment rate ($u_{r,t}$), are all heavily correlated in time. Table 2 shows the simple correlation coefficients for different years. To deal

²⁵ Kreise und kreisfreie Städte

²⁶ West-Berlin has been omitted because of its geographic situation.

²⁷ A description of the sources is found in the Appendix 2.

²⁸ According to the suggestions in Cliff / Ord (1981) and Anselin (1988) the author has experimented with the incorporation of distance measures. However the chosen matrix performs best.

Table 2: Correlation in time

local wages ($\ln w_r$)			
	1988	1989	1990
1987	0.995	0.987	0.974
1988		0.992	0.980
1989			0.988
average negotiated wages ($\ln w_r^T$)			
	1988	1989	1990
1987	0.995	0.988	0.971
1988		0.995	0.976
1989			0.985
rate of unemployment ($\ln u_r$)			
	1988	1989	1990
1987	0.973	0.949	0.927
1988		0.975	0.949
1989			0.971

with this time series property the wage curve has been estimated in (logarithmic) differences. In fact, an error correction model has been estimated by including the levels of the variables.

Since the delimitations of the local labor markets are simply the administrative boundaries, we shouldn't neglect the problem of spatial autocorrelation a priori. First, the spatial distribution of non observed local factors may cause spatial autocorrelation. Moreover from the theoretical background one would expect shocks to local employment conditions by the search behaviour of both employers and labor to spillover to the neighbouring localities. For those reasons a spatially lagged dependent variable (SLDV) framework, which assumes spatial correlation in the dependent variable as well as a spatial residual autocorrelation (SAR) approach have been utilized.²⁹

Table 3 shows the wage curve estimates, obtained by maximum likelihood (ML) estimation. The local average of national wages and the local unemployment rate are employed as exogenous variables each in levels and in differences. The average hours per worker show only effects in differences, which are also included. The lagged local wage level is introduced as a part of the implied error correction term. Moreover time dummies have been used. Note, that the change in the local average of national wages has been decomposed into three individual components: The changes in national

²⁹For a discussion of these methods see Anselin(1988).

Table 3: Wage curve estimations

dependent variable	$\Delta \ln w_{r,t}$			
method of estimation	SLDV (ML)	SLDV (ML)	SAR (ML)	SAR (ML)
fixed effects	no	yes	no	yes
LRatio(fixed-effects)		732.94		739.13
observations	981			
$W\Delta \ln w_{r,t}$	0.177	0.152		
LRatio($\rho = 0$)	23.13	20.76		
λ			0.155	0.175
LRatio($\lambda = 0$)			14.89	18.70
constant	-0.107 (-2.43)		-0.097 (-2.16)	
$\Delta \ln u_{r,t}$	-0.013 (-2.38)	-0.013 (-2.21)	-0.015 (-2.55)	-0.012 (-2.03)
$\Delta \ln w_{r,t}^T | \Delta \alpha_{s,r,t}=0$	0.830 (5.95)	1.512 (10.89)	0.842 (5.90)	1.474 (10.46)
$\Delta \ln w_{r,t}^T | \Delta w_{s,t}^T=0$	0.411 (4.95)	0.341 (4.55)	0.366 (4.59)	0.297 (4.20)
$\Delta \ln w_{r,t}^T | \Delta w_{s,t}^T, \Delta \alpha_{s,r,t}>0$	0.192 (1.82)	0.253 (2.70)	0.159 (1.54)	0.210 (2.31)
$\Delta \ln h_{r,t}$	0.095 (3.91)	0.096 (4.67)	0.090 (3.70)	0.088 (4.29)
$\ln w_{r,t-1}$	-0.029 (-4.43)	-0.793 (-20.93)	-0.030 (-4.39)	-0.798 (-21.02)
$\ln w_{r,t-1}^T$	0.052 (3.36)	0.803 (7.08)	0.052 (3.32)	0.772 (6.81)
$\ln u_{r,t-1}$	-0.006 (-4.78)	-0.029 (-3.90)	-0.007 (-4.75)	-0.025 (-3.19)
$t = 1988$	0.003 (0.99)	0.010 (1.16)	0.001 (0.21)	0.004 (0.48)
$t = 1989$	-0.003 (-1.22)	0.009 (1.72)	-0.007 (-2.40)	0.004 (0.71)
log-likelihood	2646.58	3013.06	2642.46	3012.03
R^2	0.32	0.68	0.32	0.68

wages weighted with constant shares ($\Delta \ln w_{r,t}^T |_{\Delta \alpha_{s,r,t}=0}$), the changes in local sectoral employment shares weighted with constant shares ($\Delta \ln w_{r,t}^T |_{\Delta w_{s,t}^T=0}$) as well as a mixed term. The sum of the three components is equal to the total change in the local average of negotiated wages.³⁰ The first of these terms can be interpreted as the pure effect of national wages with the employment shares held constant.

With the exception of the time dummies, the constant term and the mixed effects, each variable reported is highly significant. There is strong evidence that spatial autocorrelation matters, either modelled as a correlation in the dependent variable (SLDV), with the term $W \Delta \ln w_{r,t}$ as an explanatory variable, or as residual autocorrelation (SAR), where λ denotes the coefficient of spatial residual autocorrelation (The critical value for the Likelihood-ratio test (LRatio) of no autocorrelation is 6.635 at a level of 99% in each case).

According to all specifications there is a significant effect of local unemployment on local wages. The change in unemployment as well as the level show a negative impact, a situation which could be interpreted as supporting the hypothesis of persistence effects in unemployment.³¹ However, following the wage curve hypothesis, we should be more interested into the relation between the levels. From the estimated equations the long run solutions for the local wage rate can be computed for the fixed effects estimates of the SLDV and the SAR model respectively as:

$$\begin{aligned} \ln w_{r,t} &= f_r + 1.013 \ln w_{r,t}^T - 0.037 \ln u_r \\ \ln w_{r,t} &= f_r + 0.967 \ln w_{r,t}^T - 0.031 \ln u_r \end{aligned}$$

Where f_r denotes the fixed effect. The long run solution shows that the local wage level moves in proportion with the national wages except for the unemployment and the fixed effect.

The likelihood-ratio statistic for the hypothesis of no fixed effects is far beyond the critical level (at a level of 99 % the critical value is 389.420). The introduction of fixed effects alters the estimations of the level effects. In the estimations without fixed

³⁰Introducing $\theta_{r,s,t}$ as the sectoral share in the sum of local wages, one can find:

$$\Delta \ln w_{r,t}^T = \Delta \ln w_{r,t}^T |_{\Delta \alpha_{s,r,t}=0} + \Delta \ln w_{r,t}^T |_{\Delta w_{s,t}^T=0} + \Delta \ln w_{r,t}^T |_{\Delta w_{s,t}^T, \Delta \alpha_{s,r,t}>0}$$

where:

$$\begin{aligned} \Delta \ln w_{r,t}^T |_{\Delta \alpha_{s,r,t}=0} &\approx \sum_s \theta_{r,s,t-1} \frac{w_{s,t}^T - w_{s,t-1}^T}{w_{s,t-1}^T} \\ \Delta \ln w_{r,t}^T |_{\Delta w_{s,t}^T=0} &\approx \sum_s \theta_{r,s,t-1} \frac{\alpha_{r,s,t} - \alpha_{r,s,t-1}}{\alpha_{r,s,t-1}} \\ \Delta \ln w_{r,t}^T |_{\Delta w_{s,t}^T, \Delta \alpha_{s,r,t}>0} &\approx \sum_s \theta_{r,s,t-1} \frac{\alpha_{r,s,t} - \alpha_{r,s,t-1}}{\alpha_{r,s,t-1}} \frac{w_{s,t}^T - w_{s,t-1}^T}{w_{s,t-1}^T} \end{aligned}$$

These three components are used in the estimation.

³¹cf. Franz(1990), p.12

effects the level of the local wage shows a negative coefficient of about -0.03 which is similar to values found by Seitz (1995).³² However, if fixed effects are introduced, the coefficients become much larger with estimates of -0.79 and -0.80 . Due to the fixed effects the much higher adjustment in the long run solution is going towards a fixed spatial wage structure. Also the short run influence of the national wages is becoming significantly larger than proportional. The “overshooting” may be caused by the fixed effects in the long run solution.

Since it has been argued in the theoretical section, that the combination of the local and sectoral wage formation causes the response of the local wages to local unemployment to differ between regions, interaction terms with the rate of unemployment have been introduced (for the estimations see appendix 3). With respect to the levels and differences in log unemployment and the log local wage level, positive interaction terms with the log unemployment rate have been found. The local average of national wages shows negative interaction terms with the log unemployment. This indicates a reduced influence of the unemployment rate, stronger stationarity properties as well as a larger distance to the national wage level in regions with higher unemployment.

The further analysis of the nonlinearity is hindered by the fact that the sectoral regional wages are not observed. In order to present some preliminary results, we have to assume a general wage curve to hold across firms and sectors, so that only by observation of the local unemployment rate we could determine if all firms at that locality are restricted by the negotiated wages. Under the strong assumption, one could hope that the sample could be split into locations where unemployment is above the average such that firms are restricted, and into locations where the opposite holds. Rather ad hoc but justifiable by equal degrees of freedom, the sample was splitted at the median unemployment. To be able to estimate the spatial correlation the subsamples were restricted to those locations which fulfilled the criterion in all periods. The restricted model consists of 288 locations, each subsample consists of 144 locations. Table 4 shows the corresponding estimates.

For both equations the structural change is significant.³³ As could be expected by splitting the sample across the spatially contiguous observations the autocorrelation coefficients are not significant in all estimations. But spatial effects are still present in the spatially lagged change of wages in neighbouring regions, which are not contained in the specific subsample. This can be seen by the coefficient of $W\Delta \ln w_{-r,t}$. However the split shows a clear pattern. The levels as well as the differences in the log local unemployment rate, turn out to be insignificant in the high unemployment regions. In the low unemployment regions the differences as well as the levels are significant. This fits quite well with the combined hypothesis.

³²Seitz (1995) analyses the wage convergence. For the SLDV and SAR specification he yields -0.017 and -0.023 respectively for the local average wage.

³³The H_0 -hypothesis is rejected at a 99% level if LRatio(unrestricted model) is larger than 24.725.

Table 4: Switching regressions

dependent variable	$\Delta \ln w_{r,t}$			
method of estimation	SLDV (ML)	SLDV (ML)	SAR (ML)	SAR (ML)
sample ^{a)}	$u_{r,t} > \mu(u_{r,t})$	$u_{r,t} < \mu(u_{r,t})$	$u_{r,t} > \mu(u_{r,t})$	$u_{r,t} < \mu(u_{r,t})$
fixed effects	yes	yes	yes	yes
LRatio(unrestricted model)	94.92		100.10	
observations	432			
$W\Delta \ln w_{r,t}$	0.037	0.080		
LRatio($\rho = 0$)	0.38	1.62		
λ			0	0.117
LRatio($\lambda = 0$)				2.30
constant	0.930 (1.21)	-2.184 (-3.53)	0.936 (1.22)	-2.145 (-3.48)
$W\Delta \ln w_{-r,t}$	0.138 (2.65)	0.128 (1.54)	0.133 (2.57)	0.119 (1.43)
$\Delta \ln u_{r,t}$	0.002 (0.19)	-0.017 (-2.19)	0.003 (0.24)	-0.015 (-1.98)
$\Delta \ln w_{r,t}^T | \Delta \alpha_{s,r,t}=0$	1.467 (7.17)	1.558 (6.78)	1.477 (7.22)	1.564 (6.81)
$\Delta \ln w_{r,t}^T | \Delta w_{s,t}^T=0$	0.030 (0.32)	1.527 (9.52)	0.042 (0.45)	1.534 (9.62)
$\Delta \ln w_{r,t}^T | \Delta w_{s,t}^T, \Delta \alpha_{s,r,t}>0$	1.031 (1.71)	1.237 (8.11)	1.020 (1.69)	1.240 (8.17)
$\Delta \ln h_{r,t}$	0.123 (3.99)	0.101 (3.45)	0.123 (3.98)	0.098 (3.37)
$\ln w_{r,t-1}$	-0.910 (-16.30)	-0.688 (-13.31)	-0.913 (-16.39)	-0.691 (-13.35)
$\ln w_{r,t-1}^T$	0.631 (3.13)	1.143 (7.23)	0.632 (3.14)	1.144 (7.26)
$\ln u_{r,t-1}$	-0.011 (-0.74)	-0.022 (-2.09)	-0.011 (-0.77)	-0.020 (-1.86)
$t = 1988$	-0.011 (-0.71)	0.036 (3.04)	-0.011 (-0.73)	0.035 (2.93)
$t = 1989$	-0.003 (-0.32)	0.019 (2.48)	-0.003 (-0.35)	0.017 (2.30)
log-likelihood	1351.56	1369.86	1351.37	1370.19
R^2	0.70	0.73	0.70	0.73

^{a)} μ denotes the median.

Moreover in the high unemployment regions, there is much faster adjustment to the long run solution. The low unemployment regions show less stationary behaviour. The long run solution itself shows a clear pattern, where low unemployment regions converge to a wage level below the national average with zero fixed effects. On the opposite the low unemployment regions converge with zero fixed effects to a level above the national average. However, since the fixed effects were showing positive values for high unemployment regions and vice versa the model has been reestimated with an intercept. The value for the constant is highly significant in case of the low unemployment regions, indicating that the convergence level is much more close to the national average than the coefficient of $\ln w_{r,t-1}^T$ suggests. The different effect of the national wages in the two estimations supports the view that in low unemployment regions the negotiated wage acts restricting.

Also the change in wages due to shifting employment shares ($\Delta \ln w_{r,t}^T |_{\Delta w_{s,t}^T=0}$) is insignificant in high unemployment regions, which is strikingly different from the effect in the other regions. This points to lower employment dynamics in the local labor markets of high unemployment regions. The difference in employment dynamics casts a doubt on the single use of the unemployment rate to mirror the employment opportunities at given wages, since higher employment fluctuations increase the wage expectation at a given unemployment rate.

Finally nonlinear functions other than the logarithm have been used, to test if the simple wage curve hypothesis can be rejected as an explanation of the nonlinearity. Table 5 shows how the influence of the local unemployment rate can be explained by quadratic functions in switching regressions as presented in Table 4. Only the relevant parameters are shown, since the other parameters do not differ much.

Given all the assumptions we have made throughout the estimations, we could reject the nonlinearity to be explained by the simple wage curve hypothesis if the quadratic term does not show up in high unemployment regions. This can be rejected. But note, that the levels as well as the quadratic term has a much larger coefficient in the low unemployment regions.

4 Conclusion

Making use of the stylized fact, that the wage negotiations in Germany are conducted on a sectoral level and seem to be rather low differentiated spatially, a combined hypothesis for the local wage formation has been suggested. This consists of a firm specific wage curve and a sectoral wage bargaining. It could be shown that under reasonable assumptions the sectoral negotiations will fix the wage above the optimum firm specific wage of a share of firms such that an endogenous wage gap evolves. Since these firms

Table 5: Quadratic specification

dependent variable	$\Delta \ln w_{r,t}$			
method of estimation	SLDV (ML)	SLDV (ML)	SAR (ML)	SAR (ML)
sample ^{a)}	$u_{r,t} > \mu(u_{r,t})$	$u_{r,t} < \mu(u_{r,t})$	$u_{r,t} > \mu(u_{r,t})$	$u_{r,t} < \mu(u_{r,t})$
fixed effects	yes	yes	yes	yes
LRatio(unrestricted model)	92.57		96.69	
observations	432			
$\Delta \ln u_{r,t}$	0.001 (0.13)	-0.015 (-2.00)	0.002 (0.18)	-0.014 (-1.78)
$u_{r,t-1}$	-1.644 (-2.21)	-3.087 (-2.95)	-1.645 (-2.21)	-3.214 (-3.00)
$u_{r,t-1}^2$	11.808 (2.33)	39.584 (2.68)	11.791 (2.33)	43.032 (2.89)

^{a)} μ denotes the median.

will be restricted their behaviour to local employment conditions are quite different to those of non restricted firms which are *on* their wage curves.

The nonlinear behaviour implied by the model could not be applied adequately to the empirical analysis. Nevertheless, partially in line with the empirical studies of the wage curve hypothesis, significant structural differences have been found between high and low unemployment regions. In particular a weaker influence of unemployment on wages, a stronger stationarity in the employment and wage dynamics, and a smaller nonlinearity in the high unemployment regions were found.

The analysis suggests that with a better description of the regime a local sector faces, and with labor market data more close to the efficiency wage hypothesis which take account for employment dynamics, a significant increase in the explanatory power of the combined hypothesis of local and sectoral wage formation can be expected.

Appendix 1: Solution to the dynamic problem

As has been discussed above, the optimization problem of the firm should be modelled dynamically as in Phelps (1994), since the quitting and hiring decisions are linked in time to the stock of employees. In this section a modified elasticity condition for the formal setup of section 2.1 is derived.

The current value Hamiltonian is:

$$\mathcal{H}_i = \Pi_i + \lambda_i [h_i - q_i] E_i \quad (16)$$

λ_i : costate variable

q_i : quit rate

As optimality conditions we get:

$$1 \stackrel{!}{=} -\lambda_i \frac{\partial q_i}{\partial w_i} \quad (17)$$

$$\lambda_i \stackrel{!}{=} -p_i \left(1 - \frac{1}{\phi_i}\right) \frac{\partial F_i}{\partial L_i} \frac{\partial e_i}{\partial h_i} \quad (18)$$

$\phi_i > 1$: perceived elasticity of demand

$$r\lambda_i - \dot{\lambda}_i \stackrel{!}{=} p_i \left(1 - \frac{1}{\phi_i}\right) \frac{\partial F_i}{\partial L_i} e_i - w + \lambda_i [h_i - q_i] \quad (19)$$

$$r \stackrel{!}{=} p_i \left(1 - \frac{1}{\phi_i}\right) \frac{\partial F_i}{\partial K_i} \quad (20)$$

The first condition (17) states, that the wage is optimal at a level where the increase in direct wage costs is exactly offset by the gain from reduced quits, where λ_i is the shadow price of increasing the stock of employees at the margin. According to (18) this shadow price in optimum is just equal to marginal training costs per new employee. Equation (19) is a condition on the shadow price. At each instant of time the value of the marginal product of employment less the wage and the imputed value of an increase in the stock of employees is just equal to the own rate of return of holding an employee. In the stationary state, where the hire equals the quit rate, such that the stock of employees is constant ($\lambda_i = h_i - q_i = 0$); this condition is similar to the usual equality of the value of the marginal product and the wage rate:

$$p_i \left(1 - \frac{1}{\phi_i}\right) \frac{\partial F_i}{\partial L_i} e_i \stackrel{!}{=} w_i + r\lambda_i \quad (21)$$

The value of the marginal product exceeds the wage just to compensate for the return to the investment in the training of the employee.

The last condition (20) determines the capital demand, where capital is assumed for simplicity to be perfectly adjustable (malleable). By making use of the optimality

conditions (17,18,21) we find a modified version of Solow's elasticity condition³⁴, since it follows:

$$1 = \frac{\partial \log e_i}{\partial \log h_i} \frac{\partial \log q_i}{\partial \log w_i} \underbrace{\left(\frac{e_i}{e_i + r e'_i} \right)}_{>1} \quad (22)$$

Provided a unique solution exists (see above), this condition for a given interest rate implies an equilibrium quit rate. As above the wage curve results from the relation between the local employment rate and that firm wage which just supports this quit rate. If the firm faces a higher interest rate the last term in (5) increases and the modified Solow condition will be fulfilled at a lower wage rate. This reflects an increase in the cost of financing the training.

Appendix 2: Sources of Data

- Local data of employment, hours, and the sum of payments to employees in total manufacturing (mining included) are taken from the series E I which is published by the Statistisches Landesamt of each German state.
- Local data of the number of unemployed and the total population are taken from Eurostat Database Regio.
- The employment data for the counties and the two digit sectors according to its own sectoral classification for years 1987 to 1990 are taken from the Beschäftigtenstatistik of the Bundesanstalt für Arbeit, Nürnberg.
- National data for average yearly wages and salaries as well as the share of (blue collar) workers in total employment for two-digit sectors according to the SYPRO Classification, are taken from the series 4 - 4.1.1. of the Statistisches Bundesamt.
- The population share of people aged 15-65 has been given for the end of 1989 by the Bundesforschungsanstalt für Landeskunde und Raumordnung in: Materialien zur Raumentwicklung, 47, 1992.
- The spatial contiguity matrix is based on the 1:1-million digitized map data supplied by the Institut für angewandte Geodäsie, Frankfurt.

³⁴cf. Solow (1979).

Appendix 3:

Table 6: Estimations with interaction terms

dependent variable	$\Delta \ln w_{r,t}$	
method of estimation	SLDV (ML)	SAR (ML)
fixed effects	yes	yes
observations	981	
$W\Delta \ln w_{r,t}$	0.132	
$L\text{Ratio}(\rho = 0)$	15.74	
λ		0.141
$L\text{Ratio}(\lambda = 0)$		11.95
$\Delta \ln u_{r,t}$	0.058 (1.40)	0.051 (1.22)
$\Delta \ln w_{r,t}^T | \Delta \alpha_{s,r,t}=0$	1.386 (9.92)	1.394 (9.93)
$\Delta \ln w_{r,t}^T | \Delta w_{s,t}^T=0$	0.359 (4.83)	0.333 (4.67)
$\Delta \ln w_{r,t}^T | \Delta w_{s,t}^T, \Delta \alpha_{s,r,t}>0$	0.283 (3.01)	0.258 (2.80)
$\Delta \ln h_{r,t}$	0.087 (4.28)	0.082 (4.05)
$\ln w_{r,t-1}$	-0.400 (-3.02)	-0.415 (-3.02)
$\ln w_{r,t-1}^T$	0.049 (0.19)	0.000 (0.00)
$\ln u_{r,t-1}$	0.454 (3.07)	0.513 (3.34)
$t = 1988$	0.001 (0.07)	-0.002 (-0.28)
$t = 1989$	0.003 (0.51)	-0.000 (-0.08)
$\ln u_{r,t-1} \times \Delta \ln u_{r,t}$	0.022 (1.72)	0.019 (1.53)
$\ln u_{r,t-1} \times \ln w_{r,t-1}$	0.132 (3.25)	0.128 (3.06)
$\ln u_{r,t-1} \times \ln w_{r,t-1}^T$	-0.220 (-3.02)	-0.232 (-3.08)
$\ln u_{r,t-1} \times \ln u_{r,t-1}$	0.020 (2.29)	0.019 (2.17)
log-likelihood	3030.17	3028.28
R^2	0.69	0.69

Literature

- ANSELIN, L.: *Spatial econometrics: methods and models*. Dordrecht et al. : Kluwer Academic Publishers, 1988
- BISPINCK, R.; WSI-TARIFARCHIV: *Tarifliche Lohnstrukturanalyse*. Düsseldorf : Hans-Böckler- Stiftung, 1995
- BLANCHFLOWER, D. G.; OSWALD, A. J.: The wage curve. *Scandinavian Journal of Economics* 92 (1990), 2, 215-235
- BLANCHFLOWER, D. G.; OSWALD, A. J.: *The wage curve*. Cambridge, Mass. : Cambridge University Press, 1994
- BLIEN, U.: Die Lohnkurve von 1989. *Mitteilungen aus der Arbeitsmarkt- und Berufsforschung* 2 (1995), 2, 155-170
- BURDA, M.; MERTENS, A.: Locational competition versus cooperation in labour markets: an implicit contract reinterpretation. *Discussion Paper – Centre for Economic Policy Research* 1020 (1994)
- CALMFORS, L.; DRIFILL, J.: Bargaining Structure, Corporatism and Macroeconomic Performance. *Economic Policy* 6 (1988), 14-61
- CLIFF, A. D.; ORD, J. K.: *Spatial processes: models and applications*. 2nd ed. London : Pion Limited, 1981
- FRANZ, W.: Hysteresis in economic relationships: an overview. In: FRANZ, W. (Hrsg.): *Hysteresis effects in economic models*. Heidelberg : Physica-Verlag, 1990
- FRANZ, W.: *Arbeitsmarktökonomik*. 2nd ed. Berlin et al. : Springer, 1994
- FRANZ, W.: Die Lohnfindung in Deutschland in einer internationalen Perspektive: Ist das deutsche System ein Auslaufmodell? *Diskussionspapier – CILE / Universität Konstanz* 24 (1995)
- KLEINHÜCKELSKOTEN, H. D.; SPAETLING, D.: *Aspekte der Interdependenz zwischen Tarif- und Effektivlohnentwicklung*. Opladen : Westdeutscher Verlag, 1980
- MÖLLER, J.: *Das Hysteresis Phänomen in Arbeitslosigkeit-Inflations-Modellen: Theorie, Empirische Relevanz und wirtschaftspolitische Konsequenzen. Habilitation*. Konstanz, 1991
- PAQUE, K.-H.: East/West Ridigity in Unified Germany: Causes and Consequences / Institut of World Economics, Kiel. *Kiel Working Paper* (1993), 572
- PHELPS, E. S.: *Structural slumps: The modern equilibrium theory of unemployment, interest, and assets*. Cambridge/Mass. et London : Harvard University Press, 1994

- SACHVERSTÄNDIGENRAT: *Zeit zum Handeln – Antriebskräfte stärken. Jahresgutachten 1993/94*. Bonn : Bundesanzeiger, 1993
- SACHVERSTÄNDIGENRAT: *Den Aufschwung sichern – Arbeitsplätze schaffen. Jahresgutachten 1994/95*. Bonn : Bundesanzeiger, 1994
- SALOP, S. C.: A model of the natural rate of unemployment. *American Economic Review* **69** (1979), 1, 117–125
- SCHLICHT, E.: Labour turnover, wage structure and natural unemployment. *Zeitschrift für die gesamte Staatswissenschaft* **134** (1978), 2, 337–345
- SCHLICHT, E.: Autonomous wage inflation. *Münchener wirtschaftswissenschaftliche Beiträge* **15** (1994)
- SCHNABEL, C.: Übertarifliche Entlohnung: Einige Erkenntnisse auf Basis betrieblicher Effektivlohnstatistiken. In: GERLACH, K. (Hrsg.); SCHETTKAT, R. (Hrsg.): *Determinanten der Lohnbildung*. Berlin : Edition Sigma, 1995
- SCHWARZE, J.: Neue Befunde zur "Lohnkurve" in Deutschland: Eine Analyse mit Paneldaten für Raumordnungsregionen 1985 und 1989. *DIW- Discussionpaper* **119** (1995)
- SEITZ, H.: Regional convergence and spatial effects / Institut für Volkswirtschaftslehre und Statistik – Univ. Mannheim. *Disc.-Paper* **520** (1995)
- SHAPIRO, C.; STIGLITZ, J. E.: Equilibrium unemployment as a worker discipline device. *American Economic Review* **74** (1984), 3, 433–444
- SOLOW, R. M.: Another possible source of wage stickiness. *Journal of Macroeconomics* **1** (1979), 1, 79–82
- WIRTSCHAFTS- UND SOZIALWISSENSCHAFTLICHES INSTITUT (WSI) (EDIT.): *Tarifpolitisches Taschenbuch*. Köln : Bund- Verlag, 1995