A Dynamic Spatial Panel Data Approach to the German Wage Curve

by

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Abstract: A wage curve is a decreasing function of wages on the regional unemployment rate. Most empirical studies on the wage curve ignore possible spatial interaction effects between the regions which are the primary units of research. This paper reconsiders the western German wage curve with a special focus on the geography of labour markets. Spillovers between regions are taken into account. The paper tests whether the unemployment rate in the larger surrounding region also affects wages. In addition, agglomeration effects and effects of local monopsony are assessed.

The main data base is a random sample of 974,179 employees observed over the period 1980-2004 and covering 326 NUTS3 units (districts). This rich data set is used to estimate a dynamic wage curve according to the two-step approach of Bell et al. (2002). In the first step one controls for individual heterogeneity and in the second step one allows for spatial effects of unemployment across regions on wages. We check the sensitivity of this wage elasticity to various spatial weight matrices as well as allowing for the endogeneity of unemployment. We also estimate the wage elasticity for various population groups.

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1. Introduction

A wage curve is a decreasing function of wages on the regional unemployment rate. Starting with the seminal contributions of Blanchflower and Oswald (1994, see also 2005) many researchers have been able to find this relationship using data from over 40 countries including western economies as well as a number of developing and transitional economies. Most recently, a wage curve has been confirmed for Russia (Shilov, Moeller 2009). In this case, the size of the wage elasticity is even -0.1 matching the estimate that Blanchflower and Oswald reported in their 1994 book.

One of the limitations in this extensive research on the wage curve concerns the treatment of regions as independent units. Empirical regions of one nation, however, are connected not only by trade flows but also by labour mobility and by commuting relationships. In the standard approach on the wage curve either individual or regional panel data are used. To control for unobserved heterogeneity, regional fixed effects are usually included. However, this does not account for the spatial correlation which is introduced by the close relationship between the regions. This paper tackles this problem by using a spatial approach to the wage curve. Spillovers between regions are taken into account. The paper tests whether only the unemployment rate of a small area is relevant or whether the unemployment rate in the larger surrounding region also affects wages. In addition, the paper investigates whether agglomeration effects and influences of regional monopsony are relevant for the wage curve mechanism.

For the purpose of this study it is important to use a comprehensive data base. Previous research has shown that the wage curve at least in Germany is a rather “shy guy”, which can only be properly studied when detailed data for a long time period is available.

2. Previous studies

Previous studies which used a spatial approach to German data include Buettner (1999), Pannenberg and Schwarze (2000) and Longhi, Nijkamp and Poot (2006). Buettner (1999) seems to have been the first to estimate a spatial panel model for Germany using maximum likelihood methods. However, he did not include the log of the regional unemployment rate as is usual in the wage curve approach. Instead he used the inverse of the regional unemployment rate and had to evaluate the wage elasticities at various levels of unemployment. Buettner found a small elasticity varying between -0.04 at an unemployment rate of 2.5% to -0.005 at an unemployment rate of 18%.

Pannenberg, and Schwarze (2000) considered a regional panel for 74 regions of West Germany observed over the period 1985-1994. They estimated a dynamic wage curve and checked its robustness with respect to spatial correlation in regional unemployment. They found it impossible to accurately identify the effects of spatial unemployment rates due to its multicollinearity with the local unemployment rate.

More recently, Longhi, Nijkamp and Poot (2006) estimated a wage curve with spatially weighted unemployment rates included as an extra regressor. They estimated separate models for regions with different degrees of agglomeration. They found that the wage curve is more pronounced in rural areas than in core cities. This is explained by the fact that labour demand in these rural areas may be characterised by higher degrees of monopsony (see Manning 2003 & 2004).

Our paper differs from those of Buettner (1999), Longhi et al. (2006) and others (like Pannenberg, Schwarze 2000) in two important respects. We use individual data based on a random sample of 974,179 employees observed over the period 1980-2004 and covering 326 NUTS3 units, whereas these papers used average wage data across German regions. Our richer data set allows us to estimate a dynamic wage curve using the two-step approach of Bell et al. (2002). In the first step we control for individual heterogeneity and in the second step we allow for spatial effects of unemployment across regions on wages. We check the sensitivity of this wage elasticity to various spatial weight matrices as well as allowing for endogeneity of unemployment. Buettner (1999) and Longhi et al. (2006) included square terms of unemployment and the latter study even included an interaction term of spatial weighted unemployment with local unemployment. Their spatial weight matrix is based upon the Euclidean distance between regions.

The Longhi et al. (2006) paper is the closest to our work but it is based on average wage data. Their control variables include the share of women in employment; the share of workers employed in firms with less than 20 employees; the share of less educated workers; and the share of workers employed in agriculture in region *j* at time *t*. Without spatial weighted unemployment, they find a wage elasticity of -0.02 at an average unemployment rate of 7.6%, and -0.04 at a maximum rate of unemployment of 20.6%. Instrumenting for endogeneity of unemployment by its lagged value, they get a lower wage elasticity of -0.01 at an average unemployment rate of 7.6%, and this becomes positive at higher unemployment rates.

The inclusion of spatial weighted unemployment is an important device to test the effects of a hierarchy of regions. Based on efficiency wage models as well as wage negotiation approaches, the theory of the wage curve gives no hints for the proper delineation of regional labour markets. In our case the regional units we observe are sufficiently small to allow us to test for the effects of the unemployment rate of neighbouring regions. In contrast to previous empirical studies, we are able to estimate this wage elasticity for various population groups (including young versus old, men versus women, less educated versus highly educated, German natives versus foreigners). These groups have different competitive positions in the labour market, and they may be affected differently by local monopsonies.

3. Empirical model

Following Bell et al. (2002), we analyse the wage curve in two steps. In the first step a model is estimated for each region separately to adjust wages for individual composition effects. In the second step these adjusted wages are used to estimate the wage curve. To control for individual heterogeneity a `first stage panel´ wage equation is estimated for each region *j* as follows:

$$W_{ijt} = \alpha_i + \alpha_{jt} + \sum_{k=1}^{K} X_{ijtk}\beta_{jk} + \varepsilon_{ijt} \qquad (1)$$

$i = 1,...,N$ $\quad j = 1,...,J$ $\quad$ and $\quad t = 1,...,T.$

where W_{ijt} is the log wage rate of individual *i* observed in region *j* in period *t*. X_{ijtk} is a set of $k = 1,\ldots, K$ measured characteristics of individual *i* (such as age, age^2, gender, education, occupation etc.), α_i is the *i*-th individual effect, α_{jt} is the time effect for region *j*, and ε_{ijt} is the remainder error term. The estimate of α_{jt}, obtained by running a panel regression with fixed effects for each region *j*, is denoted by the `composition corrected wage´ in the regional panel model. We skip the alternative approach that Bell et al. (2002) used, which is a `first stage cross-section´ wage equation, because the first stage panel provides a better control for individual heterogeneity. In the second stage regression, Bell et al. (2002) include a dynamic formulation given by:

$$\alpha_{jt} = \mu_j + \lambda_t + \beta_1\alpha_{jt-1} + \beta_2 u_{jt} + \sum_{j=2}^{J}(\gamma_j{}'D_j)t + v_{jt} \qquad (2)$$

where u_{jt} is the log of the regional unemployment rate in region *j* in period *t*. D_j is a region dummy. The number of observations for this regression is *JT*. We include specific time trends to capture systematic trends in region-specific wage pressure. The fact that u_{jt} does not vary with *i* implies that the effective number of observations is *JT* and not *NT*, see Card (1995). Therefore, we follow Bell et al., who prefer the two-stage method, since if there are unobserved variables at regional level, the combination of time and regional fixed effects will take them into account in the second stage of the analysis, see also Baltagi, Blien and Wolf (2008).

One point of departure from the approach chosen by Bell et al. (2002) and Baltagi et al. (2008) is the inclusion of a spatially extended version of the unemployment rate. Our regional units are quite small; we have 326 representing western Germany in total. Wages could therefore be expected to depend not only on supply and demand in a worker's home region but also on the labour market situation of neighbouring regions.

$$\alpha_{jt} = \mu_j + \lambda_t + \beta_1 \alpha_{jt-1} + \beta_2 u_{jt} + \beta_3 G u_t + \sum_{j=2}^{J} (\gamma_j{}' D_j) t + \nu_{jt} \qquad (3)$$

The matrix G is a spatial weight matrix which symbolizes the connections between regions. It can be constructed in various ways which are discussed later. G is of dimension $J \times J$ and collects the regional weights g_{kj}. Its main diagonal elements are zero and it is row-normalised. This means that each row sums to one. u_t is a vector collecting all the regional unemployment rates u_{jt}. A spatially weighted unemployment regressor (Gu_t) is therefore included to show how the labour market conditions of the neighbouring regions influence local wages.

4. Data

In this section we briefly give an overview on our data base. Further details are given in the appendix. The IAB Employment Sample is a random sample which is not our exclusive property but may be used by other researchers as well, since it is a scientific use file. It consists of 974,179 individuals drawn from the population of employees who are covered by social insurance. This group comprises over 80% of all employment in Germany. Civil servants and workers with very low incomes are not observed. The total number of observations in our sample is 9,188,532 covering 326 districts over the period 1980-2004. These districts are the administrative units of western Germany and are the smallest regions for which unemployment rates are available.

Since the data are extracted from administrative files used to compute the contributions to social insurance (which are later the basis of pensions paid), they are very reliable. No problem of recall or reporting is encountered as it is the case in population surveys. Two limitations of the data, however, should be briefly discussed. One limitation is that the wages reported are censored for groups with high incomes. For individuals with wages exceeding a defined threshold, which is the contribution assessment ceiling of the social insurance system, only this threshold value is reported. In these cases the exact wage value is unknown. For example, in 1989, this threshold was a monthly income of 3,119 Euros. Tests were carried out using refined methods for dealing with this kind of problem, i. e. multiple imputation (Rubin 1987 & 1996) of wages above the threshold. Using panel data on a shorter time period these tests showed only very small changes in the results on the wage curve. Since additional assumptions are required in order to use imputation, this line of research was not pursued any further. Another limitation is that no exact working hours are reported in the data. To avoid any contamination with working time effects as far as possible, only people working full-time were included in our data base. We expect that small variations in working time due to overtime etc. are taken out by time and industry dummies. Of course slight uncertainties about the size of this effect remain.

5. Main results on the wage curve

Column 1 in Table 1 shows the results for the dynamic German wage curve for all workers based on the `first stage panel´ wage equation given in (1). Focusing on the equations without the spatially weighted unemployment regressor, the upper half of the table gives the results of the standard fixed effects estimator which is instrumented in the lower half by lagged values of the unemployment rate, see Bell et al. (2002).

Only the lagged wage coefficient and the short-run and long-run unemployment elasticities are reported.[a] In the first step regressions, we include age, age^2, gender, four worker qualification categories, six employment status categories, fourteen occupational categories, thirty-one industry categories and nine establishment size categories.[b]

Some basic results are robust to the method of estimation used, whether fixed effects or fixed effects IV. We find that the lagged wage is significant, i.e. β_1 is significantly different from zero, rejecting the static wage equation in favour of a dynamic specification. This estimate of β_1 is so far from unity (a maximum of 0.6 with a very small standard error of 0.01) that we reject the unit root hypothesis implied by the pure Phillips curve. This coefficient estimate is slightly smaller when we instrument for unemployment by its lagged values. The short-run and long-run elasticities of wages with respect to unemployment are relatively small but significant. For all workers the effect of regional unemployment on wages is -0.016 in the short run and -0.037 in the long run. These elasticities are slightly smaller when we do not instrument for unemployment. It is interesting to compare these results to those of Bell et al. For the UK they obtain a coefficient that is about three times larger than the one we find for Germany.

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[a] The results on the control variables are available upon request from the authors.

[b] For a detailed description of the variables used, see the data appendix.

Table 1: All regions

German dynamic wage curve by type of worker including spatial effects of unemployment
The IAB Employment Sample: 1980-2004

	1	2	3	4	5	6	7	8
	ALL	ALL Spat Ex.	MALE	MALE Spat Ex.	FEMALE	FEMALE Spat. Ex.	GERMAN	GERMAN Spat. Ex.
Fixed Effects	**N=7824**							
W_{ijt-1}	0.5813 (0.0134)	0.5812 (0.0134)	0.5641 (0.0142)	0.5642 (0.0142)	0.5590 (0.0122)	0.5587 (0.0122)	0.5817 (0.0131)	0.5815 (0.0131)
Short-Run u_{jt}	-0.0114 (0.0008)	-0.0111 (0.0014)	-0.0121 (0.0009)	-0.0121 (0.0015)	-0.0098 (0.0014)	-0.0078 (0.0022)	-0.0111 (0.0008)	-0.0106 (0.0014)
Long-Run u_{jt}	-0.0273 (0.0020)	-0.0264 (0.0032)	-0.0277 (0.0020)	-0.0279 (0.0035)	-0.0222 (0.0031)	-0.0178 (0.0049)	-0.0256 (0.0020)	-0.0253 (0.0033)
Spatial u^*_{jt}		-0.0006 (0.0017)		0.0001 (0.0018)		-0.0032 (0.0027)		-0.0009 (0.0017)
IV (FE)[a]								
W_{ijt-1}	0.5526 (0.0109)	0.5527 (0.0109)	0.5310 (0.0108)	0.05311 (0.0109)	0.5351 (0.0109)	0.5351 (0.0109)	0.5531 (0.0109)	0.5532 (0.0109)
Short-Run u_{jt}	-0.0164 (0.0016)	-0.0175 (0.0030)	-0.0179 (0.0018)	-0.0201 (0.0033)	-0.0136 (0.0028)	-0.0118 (0.0052)	-0.0155 (0.0017)	-0.0163 (0.0030)
Long-Run u_{jt}	-0.0366 (0.0035)	-0.0391 (0.0045)	-0.0383 (0.0037)	-0.0429 (0.0080)	-0.0292 (0.0050)	-0.0253 (0.0063)	-0.0347 (0.0035)	-0.0365 (0.0032)
Spatial u^*_{jt}		0.0020 (0.0034)		0.0037 (0.0038)		-0.0029 (0.0061)		0.0014 (0.0035)

	9	10	11	12	13	14	15	16	17	18
	YOUNG	YOUNG Spat. Ex.	OLD	OLD Spat Ex.	FOREIG	FOREIG. Spat. Ex.	LowQual .	LowQual . Spat. Ex.	HighQual .	HighQual . Spat. Ex.
Fixed Effects										
W_{ijt-1}	0.5962 (0.0125)	0.5959 (0.0125)	0.5560 (0.0127)	0.5559 (0.0127)	0.5196 (0.0298)	0.5177 (0.0301)	0.4891 (0.0107)	0.4891 (0.0107)	0.442 (0.0720)	0.4425 (0.0720)
Short-Run u_{jt}	-0.0149 (0.0015)	-0.0133 (0.0024)	-0.0102 (0.0010)	-0.0094 (0.0014)	-0.0158 (0.0033)	-0.0266 (0.0054)	-0.0132 (0.0014)	-0.0128 (0.0022)	-0.0050 (0.0043)	-0.0079 (0.0057)
Long-Run u_{jt}	-0.0368 (0.0037)	-0.0329 (0.0060)	-0.0229 (0.0021)	-0.0212 (0.0034)	-0.0328 (0.0069)	-0.0551 (0.0104)	-0.0258 (0.0029)	-0.0250 (0.0048)	-0.0090 (0.0079)	-0.0142 (0.0104)
Spatial u^*_{jt}		-0.0026 (0.0030)		-0.0012 (0.0018)		0.0177 (0.0068)		-0.0006 (0.0027)		0.0057 (0.0048)
IV (FE)[a]										
W_{ijt-1}	0.5766 (0.0108)	0.5767 (0.0108)	0.5180 (0.0109)	0.5183 (0.0109)	0.4891 (0.0118)	0.4856 (0.0120)	0.4621 (0.0116)	0.4633 (0.0117)	0.4790 (0.0106)	0.4790 (0.0106)
Short-Run u_{jt}	-0.0180 (0.0032)	-0.0201 (0.0059)	-0.0139 (0.0018)	-0.0129 (0.0034)	-0.0196 (0.0071)	-0.0361 (0.0135)	-0.0134 (0.0030)	-0.0067 (0.0055)	-0.0135 (0.0071)	-0.0201 (0.0134)
Long-Run u_{jt}	-0.0425 (0.0074)	-0.0476 (0.0079)	-0.0289 (0.0037)	-0.0267 (0.0027)	-0.0383 (0.0139)	-0.0702 (0.0259)	-0.0249 (0.0055)	-0.0125 (0.0102)	-0.0259 (0.0137)	-0.0385 (0.0257)
Spatial u^*_{jt}		0.0034 (0.0068)		-0.0013 (0.0039)		0.0272 (0.0157)		-0.0096 (0.0064)		0.0097 (0.0156)

a The IV models instruments for unemployment and spatial unemployment by its lags, see Bell et al. (2002).

Blanchflower and Oswald (1994) and Card (1995) suggest the estimation of different wage curves for different population groups. One would expect the wage to be more flexible the weaker the bargaining power of the particular group. Blanchflower and Oswald find that younger workers have a significantly higher wage elasticity than older workers. For western Germany, the fixed effects IV-estimator of this elasticity is larger for younger workers (below the age of 30) than older workers (above the age of 45), -0.018 as compared to -0.014 in the short run, and -0.042 and -0.029 respectively in the long run (see columns 9 and 11 of Table 1).

Blanchflower and Oswald (1994) and Card (1995) find for the U.S. data that men's wages are more sensitive to the unemployment rate than women's wages. This is also true for western Germany. In the short run the elasticity is -0.018 for males (column 3), as compared to -0.014 for females (column 5). It is -0.038 and -0.029 respectively in the long run. In western Germany, we find that the unemployment elasticity for less qualified workers is -0.0134 (column 15) as compared to -0.0135 for highly qualified workers (column 17) in the short run, and -0.025 as compared to -0.026 in the long run. The estimates for the highly qualified are not significant, however. Other groups that are interesting to compare are those of foreigners versus Germans. The literature on international migration was able to show that in many countries foreigners and natives are separated by labour market barriers (Ottaviano, Peri 2006, Bruecker, Jahn 2008). For migrants a stronger effect of unemployment on wages should be expected since they have lower bargaining power due to their migration background. This is confirmed by our results. The short-run effect is -0.016 in the case of Germans (column 7) and -0.020 in the case of foreigners (column 13). This corresponds to long-run effects of -0.035 and -0.038 respectively.

In column (2) the basic model is extended by adding the spatially weighted unemployment rate. Technically, this is done by premultiplying the vector of the unemployment rate by the matrix of spatial weights *G*. In Table 1 we use a contiguity matrix for *G*, i. e. the nonzero elements of *G* represent regions that have a common border. In a first step these elements are set to 1, in a second step the matrix is row-normalised by dividing each element by the row sum. This means that the rows sum up to unity. Of course, the main diagonal elements of *G* are zero.

Table 2: Type 1 - Regions with core cities

German dynamic wage curves by type of workers including spatial effects of unemployment
The IAB Employment Sample: 1980-2004

	1	2	3	4	5	6	7	8
	ALL	ALL Spat.Ex.	MALE	MALE Spat Ex.	FEMALE	FEMALE Spat. Ex.	GERMAN	GERMAN Spat. Ex.
Fixed Effects								
W_{ijt-1}	0.5618 (0.0164)	0.5614 (0.0164)	0.5502 (0.0165)	0.5502 (0.0216)	0.5086 (0.0173)	0.5080 (0.0212)	0.5613 (0.0216)	0.5603 (0.0216)
Short-Run u_{jt}	-0.0116 (0.0014)	-0.0098 (0.0020)	-0.0134 (0.0016)	-0.0131 (0.0023)	-0.0093 (0.0023)	-0.0040 (0.0034)	-0.0108 (0.0014)	-0.0085 (0.0020)
Long-Run u_{jt}	-0.0266 (0.0030)	-0.0223 (0.0046)	-0.0297 (0.0033)	-0.0292 (0.0050)	-0.0189 (0.0046)	-0.0082 (0.0070)	-0.0247 (0.0031)	-0.0194 (0.0047)
Spatial u^*_{jt}		-0.0031 (0.0025)		-0.0004 (0.0028)		-0.0088 (0.0041)		-0.0038 (0.0025)
IV (FE)[a]								
W_{ijt-1}	0.5210 (0.0186)	0.5228 (0.0186)	0.5021 (0.0186)	0.5040 (0.0185)	0.4935 (0.0189)	0.4934 (0.0189)	0.5228 (0.0186)	0.5231 (0.0185)
Short-Run u_{jt}	-0.0196 (0.0031)	-0.0154 (0.0052)	-0.0214 (0.0034)	-0.0187 (0.0059)	-0.0178 (0.0049)	-0.0115 (0.0086)	-0.0182 (0.0031)	-0.0130 (0.0053)
Long-Run u_{jt}	-0.0409 (0.0060)	-0.0322 (0.0107)	-0.0429 (0.0066)	-0.0377 (0.0117)	-0.0305 (0.0096)	-0.0210 (0.0168)	-0.0382 (0.0062)	-0.0273 (0.0109)
Spatial u^*_{jt}		-0.0056 (0.0057)		-0.0024 (0.0065)		-0.0106 (0.0094)		-0.0077 (0.0058)

	9	10	11	12	13	14	15	16	17	18
	YOUNG	YOUNG Spat. Ex.	OLD	OLD Spat.Ex.	FOREIG	FOREIG. Spat. Ex.	LowQual .	LowQual . Spat. Ex.	HighQual .	HighQual . Spat. Ex.
Fixed Effects										
W_{ijt-1}	0.6062 (0.0161)	0.6062 (0.0198)	0.5531 (0.0164)	0.5517 (0.0224)	0.4265 (0.0367)	0.4210 (0.0367)	0.4470 (0.0182)	0.4463 (0.0275)	0.4762 (0.0431)	0.4756 (0.0432)
Short-Run u_{jt}	-0.0145 (0.0027)	-0.0111 (0.0041)	-0.0086 (0.0016)	-0.0052 (0.0023)	-0.0135 (0.0044)	-0.0261 (0.0061)	-0.0122 (0.0025)	-0.0149 (0.0042)	-0.0143 (0.0038)	-0.0099 (0.0057)
Long-Run u_{jt}	-0.0369 (0.0063)	-0.0283 (0.0103)	-0.0193 (0.0034)	-0.0116 (0.0051)	-0.0235 (0.0074)	-0.0451 (0.0103)	-0.0221 (0.0045)	-0.0269 (0.0075)	-0.0274 (0.0075)	-0.0190 (0.0112)
Spatial u^*_{jt}		-0.0057 (0.0049)		-0.0057 (0.0028)		0.0209 (0.0077)		0.0044 (0.0050)		-0.0073 (0.0072)
IV (FE)[a]										
W_{ijt-1}	0.5768 (0.0178)	0.5783 (0.0179)	0.5108 (0.0181)	0.5103 (0.0180)	0.4007 (0.0193)	0.3857 (0.0202)	0.4175 (0.0197)	0.4176 (0.0200)	0.4725 (0.0184)	0.4693 (0.0185)
Short-Run u_{jt}	-0.0180 (0.0060)	-0.0085 (0.0104)	-0.0147 (0.0034)	-0.0072 (0.0058)	-0.0182 (0.0093)	-0.0506 (0.0167)	-0.0126 (0.0054)	-0.0132 (0.0095)	-0.0147 (0.0085)	0.0168 (0.0148)
Long-Run u_{jt}	-0.0426 (0.0138)	-0.0202 (0.0243)	-0.0301 (0.0068)	-0.0220 (0.0119)	-0.0303 (0.0154)	-0.0824 (0.0264)	-0.0216 (0.0092)	-0.0227 (0.0162)	-0.0278 (0.0160)	0.0316 (0.0320)
Spatial u^*_{jt}		-0.0142 (0.0113)		-0.0108 (0.0065)		0.0540 (0.0185)		0.0028 (0.0105)		-0.0483 (0.0164)

a This instruments for unemployment and spatial unemployment by its lags, see Bell et al. (2002).

The results on spatial unemployment for all employed workers are not significant at the 5%-level. Local unemployment, i.e. unemployment in one’s own region is the only important labour market indicator. This result holds for all the subgroups discussed earlier. This is a remarkable result, because it may indicate that the relevant actors on the labour market are myopic. They do not care about labour market conditions only some kilometres away. Another explanation for the lack of influence of the labour market situation of the surrounding areas is the existence of commuting and migration cost. Workers do not respond to spatial differences in the unemployment rate, because there is a cost in doing this. We will carry out some robustness checks on the effect of spatial unemployment later.

6. Important spatial aspects of the wage curve

Following Longhi et al. (2006), Tables 2-4 give results for different types of regions. The idea here is that in regions with large agglomerations workers have a choice of firms, whereas in the rural areas they may depend on one employer. In the rural area case, the wage curve can be expected to be more pronounced than in regions with core cities. The background for this research is that the extent of monopsony (see Manning 2003 & 2004) in the labour market depends on the nature of the respective region. Whereas outright monopsony is rare in a modern economy, different degrees of monopsonistic competition can be expected from different types of regions. The crucial interacting variables concern the very number of firms located in an area and the accessibility of the area. Both variables are correlated with the existence of agglomerations and their size.

To classify regions we use a typology which is widely applied in empirical research and was originally created by a German research institute, the Federal Office for Building and Regional Planning (BBR). There, regions are classified into 9 different types. Like Longhi et al. (2006), we use a coarser classification based on three classes: regions with large core cities (Table 2), regions with conurbational features (Table 3) and regions belonging to the rural country (Table 4).

Table 3: Type 2 - Regions with conurbational features

German dynamic wage curves by type of workers including spatial effects of unemployment

The IAB Employment Sample: 1980-2004

	1	2	3	4	5	6	7	8
	ALL	ALL Spat Ex.	MALE	MALE Spat Ex.	FEMALE	FEMALE Spat. Ex.	GERMAN	GERMAN Spat. Ex.
Fixed Effects								
W_{ijt-1}	0.5894 (0.0144)	0.5896 (0.0145)	0.5647 (0.0149)	0.5647 (0.0218)	0.5764 (0.0148)	0.5763 (0.0181)	0.5895 (0.0203)	0.5898 (0.0203)
Short-Run u_{jt}	-0.0126 (0.0011)	-0.0130 (0.0017)	-0.0137 (0.0012)	-0.0138 (0.0023)	-0.0106 (0.0021)	-0.0097 (0.0032)	-0.0124 (0.0013)	-0.0131 (0.0021)
Long-Run u_{jt}	-0.0306 (0.0032)	-0.0318 (0.0050)	-0.0314 (0.0032)	-0.0317 (0.0052)	-0.0250 (0.0050)	-0.0229 (0.0075)	-0.0302 (0.0032)	-0.0319 (0.0051)
Spatial u^*_{jt}		0.0009 (0.0023)		0.0002 (0.0028)		-0.0015 (0.0041)		0.0021 (0.0026)
IV (FE)[a]								
W_{ijt-1}	0.5762 (0.0161)	0.5758 (0.0161)	0.5394 (0.0163)	0.5393 (0.0163)	0.5529 (0.0162)	0.5529 (0.0162)	0.5754 (0.0162)	0.5749 (0.0162)
Short-Run u_{jt}	-0.0132 (0.0023)	-0.0155 (0.0040)	-0.0151 (0.0024)	-0.0176 (0.0043)	-0.0125 (0.0040)	-0.0126 (0.0071)	-0.0130 (0.0023)	-0.0155 (0.0041)
Long-Run u_{jt}	-0.0310 (0.0051)	-0.0366 (0.0092)	-0.0328 (0.0051)	-0.0383 (0.0091)	-0.0279 (0.0088)	-0.0281 (0.0159)	-0.0305 (0.0052)	-0.0365 (0.0093)
Spatial u^*_{jt}		0.0038 (0.0051)		0.0043 (0.0041)		0.0001 (0.0092)		0.0041 (0.0051)

	9	10	11	12	13	14	15	16	17	18
	YOUNG	YOUNG Spat. Ex.	OLD	OLD Spat. Ex.	FOREIG	FOREIG. Spat. Ex.	LowQual.	LowQual. Spat. Ex.	HighQual.	HighQual. Spat. Ex.
Fixed Effects										
W_{ijt-1}	0.5763 (0.0150)	0.5753 (0.0191)	0.5462 (0.0151)	0.5461 (0.0194)	0.4687 (0.0545)	0.4687 (0.0546)	0.4746 (0.0164)	0.4742 (0.0227)	0.1682 (0.0562)	0.1682 (0.0563)
Short-Run u_{jt}	-0.0175 (0.0023)	-0.0137 (0.0035)	-0.0118 (0.0013)	-0.0117 (0.0022)	-0.0167 (0.0048)	-0.0160 (0.0076)	-0.0152 (0.0021)	-0.0131 (0.0035)	-0.0046 (0.0052)	-0.0050 (0.0079)
Long-Run u_{jt}	-0.0413 (0.0054)	-0.0323 (0.0083)	-0.0260 (0.0033)	-0.0257 (0.0049)	-0.0314 (0.0085)	-0.0301 (0.0136)	-0.0289 (0.0043)	-0.0249 (0.0067)	-0.0055 (0.0078)	-0.0060 (0.0096)
Spatial u^*_{jt}		-0.0067 (0.0046)		-0.0003 (0.0027)		-0.0012 (0.0093)		-0.0037 (0.0045)		0.0007 (0.0099)
IV (FE)[a]										
W_{ijt-1}	0.5601 (0.0165)	0.5602 (0.0165)	0.5091 (0.0165)	0.5097 (0.0165)	0.4256 (0.0190)	0.4260 (0.0190)	0.4505 (0.0177)	0.4504 (0.0177)	0.2508 (0.0182)	0.2510 (0.0182)
Short-Run u_{jt}	-0.0195 (0.0045)	-0.0205 (0.0080)	-0.0134 (0.0025)	-0.0149 (0.0045)	-0.0244 (0.0099)	-0.0191 (0.0178)	-0.0137 (0.0042)	-0.0106 (0.0074)	-0.0177 (0.0094)	-0.0332 (0.0171)
Long-Run u_{jt}	-0.0444 (0.0101)	-0.0467 (0.0182)	-0.0274 (0.0050)	-0.0304 (0.0091)	-0.0425 (0.0171)	-0.0333 (0.0309)	-0.0249 (0.0074)	-0.0192 (0.0137)	-0.0236 (0.0126)	-0.0444 (0.0229)
Spatial u^*_{jt}		0.0016 (0.0103)		0.0024 (0.0057)		-0.0069 (0.0229)		-0.0051 (0.0095)		0.0274 (0.0220)

a This instruments for unemployment and spatial unemployment by its lags, see Bell et al. (2002).

Table 4: Type 3 - Regions in the rural country

German dynamic wage curves by type of workers including spatial effects of unemployment

The IAB Employment Sample: 1980-2004

	1	2	3	4	5	6	7	8
	ALL	ALL Spat.Ex.	MALE	MALE Spat Ex.	FEMALE	FEMALE Spat. Ex.	GERMAN	GERMAN Spat. Ex.
Fixed Effects								
W_{ijt-1}	0.5650 (0.0223)	0.5643 (0.0223)	0.5407 (0.0229)	0.5400 (0.0336)	0.5688 (0.0223)	0.5689 (0.0246)	0.5691 (0.0275)	0.5681 (0.0277)
Short-Run u_{jt}	-0.0110 (0.0021)	-0.0098 (0.0028)	-0.0107 (0.0023)	-0.0093 (0.0034)	-0.0074 (0.0039)	-0.0082 (0.0051)	-0.0106 (0.0021)	-0.0091 (0.0031)
Long-Run u_{jt}	-0.0252 (0.0050)	-0.0224 (0.0073)	-0.0234 (0.0052)	-0.0202 (0.0076)	-0.0172 (0.0089)	-0.0190 (0.0118)	-0.0246 (0.0050)	-0.0210 (0.0074)
Spatial u^*_{jt}		-0.0023 (0.0034)		-0.0028 (0.0043)		0.0015 (0.0063)		-0.0029 (0.0040)
IV (FE)a								
W_{ijt-1}	0.5151 (0.0257)	0.5144 (0.0260)	0.5028 (0.0254)	0.5022 (0.0257)	0.5375 (0.0246)	0.5373 (0.0246)	0.5221 (0.0255)	0.5222 (0.0258)
Short-Run u_{jt}	-0.0229 (0.0057)	-0.0323 (0.0084)	-0.0238 (0.0060)	-0.0353 (0.0089)	-0.0133 (0.0101)	-0.0158 (0.0149)	-0.0202 (0.0057)	-0.0291 (0.0084)
Long-Run u_{jt}	-0.0473 (0.0112)	-0.0665 (0.0167)	-0.0478 (0.0117)	-0.0709 (0.0173)	-0.0287 (0.0215)	-0.0342 (0.0318)	-0.0422 (0.0114)	-0.0609 (0.0170)
Spatial u^*_{jt}		0.0164 (0.0091)		0.0202 (0.0097)		0.0040 (0.0164)		0.0158 (0.0091)

	9	10	11	12	13	14	15	16	17	18
	YOUNG	YOUNG Spat. Ex.	OLD	OLD Spat. Ex.	FOREIG	FOREIG. Spat. Ex.	LowQual.	LowQual. Spat. Ex.	HighQual.	HighQual. Spat. Ex.
Fixed Effects										
W_{ijt-1}	0.6250 (0.0218)	0.6252 (0.0284)	0.5628 (0.0227)	0.5627 (0.0253)	0.6010 (0.0404)	0.5950 (0.0411)	0.5481 (0.0234)	0.5475 (0.0275)	0.6772 (0.0894)	0.6770 (0.0895)
Short-Run u_{jt}	-0.0133 (0.0041)	-0.0137 (0.0056)	-0.0110 (0.0025)	-0.0113 (0.0034)	-0.0263 (0.0110)	-0.0483 (0.0146)	-0.0126 (0.0040)	-0.0199 (0.0056)	-0.0229 (0.0156)	-0.0179 (0.0158)
Long-Run u_{jt}	-0.0356 (0.0107)	-0.0367 (0.0152)	-0.0253 (0.0058)	-0.0259 (0.0077)	-0.0659 (0.0276)	-0.1192 (0.0344)	-0.0279 (0.0091)	-0.0243 (0.0123)	-0.0711 (0.0467)	-0.0554 (0.0482)
Spatial u^*_{jt}		0.0008 (0.0070)		0.0005 (0.0041)		0.0420 (0.0181)		-0.0037 (0.0076)		-0.0097 (0.0156)
IV (FE)a										
W_{ijt-1}	0.6103 (0.0250)	0.6135 (0.0250)	0.5267 (0.0250)	0.5212 (0.0258)	0.5752 (0.0247)	0.5656 (0.0259)	0.5217 (0.0258)	0.5217 (0.0258)	0.6025 (0.0213)	0.6030 (0.0214)
Short-Run u_{jt}	-0.0189 (0.0110)	-0.0335 (0.0159)	-0.0171 (0.0065)	-0.0238 (0.0097)	-0.0256 (0.0318)	-0.0636 (0.0475)	-0.0092 (0.0106)	-0.0056 (0.0147)	-0.0389 (0.0337)	-0.0543 (0.0493)
Long-Run u_{jt}	-0.0485 (0.0273)	-0.0867 (0.0402)	-0.0361 (0.0133)	-0.0497 (0.0196)	-0.0604 (0.0749)	-0.1464 (0.1076)	-0.0192 (0.0220)	-0.0116 (0.0333)	-0.0978 (0.0842)	-0.1368 (0.1239)
Spatial u^*_{jt}		0.0255 (0.0173)		0.0118 (0.0106)		0.0666 (0.0527)		-0.0068 (0.0201)		0.0236 (0.0543)

a This instruments for unemployment and spatial unemployment by its lags, see Bell et al. (2002).

Unlike Longhi et al. (2006), we do find a wage curve for all types of regions. In their case, the wage curve was not significant in agglomerations. In our case, the wage elasticity is always negative and significant. It is slightly higher in absolute value for rural areas, see Table 4. This is -0.023 in the short run and -0.047 in the long run (for all employees and without spatial weighted unemployment). Therefore, the findings correspond to the hypothesis about local monopsony. Whereas in agglomerations workers have a choice between different firms, they depend to a relatively high degree on a single firm in rural areas. Under these conditions firms are more likely to enforce their claims than under the pressure of competing firms.

Spatial weighted unemployment is not significant for all employees and for most subgroups. One main exception is the labour market of males in the rural country (Table 4, Model 4). In this case, the wage elasticity due to the short run local unemployment rate increases from -0.024 to -0.035 and the wage elasticity due to the long run local unemployment elasticity from -0.048 to -0.071. However, the spatial weighted unemployment elasticity is positive and significant (0.020). The same phenomenon of positive spatial weighted unemployment elasticity was also reported by Longhi et al. (2006).

One explanation of this result is that the unemployment rates of neighbouring regions are highly correlated. Between variables in levels, the correlation is 0.85, between variables after carrying out the within-transformation, it is 0.95. This might prevent a complete separation of the influences of local and spatial unemployment, in spite of the long panel we use.

Focusing on German versus Foreign, we notice a drastic increase in the wage elasticity when we introduce spatial weighted unemployment effects for foreign workers in regions with core cities. This elasticity in Table 2 for core cities goes up from -0.018 to -0.051 in the short run, and -0.030 to -0.082 in the long run. However, the spatial weighted unemployment elasticity is positive and significant (0.054).

Table 5: Different spatial weighting matrices in models for different region types
Dynamic models of the wage curve with fixed effects

G1: Based on contiguity
G2: Based on commuting flows
G3: Based on distance (inverse)
G4: Based on traveling time (=0 if >1 hour)

	1	2	3	4	5	6	7	8
	ALL G1	ALL G2	ALL G3	ALL G4	Typ1 G1	Typ1 G2	Typ1 G3	Typ1 G4
Fixed Effects								
W_{ijt-1}	0.5812 (0.0135)	0.5816 (0.0135)	0.5813 (0.0135)	0.5817 (0.0135)	0.5614 (0.0221)	0.5618 (0.0221)	0.5613 (0.0222)	0.5617 (0.0222)
Short-Run u_{jt}	-0.0111 (0.0014)	-0.0127 (0.0014)	-0.0116 (0.0014)	-0.0123 (0.0013)	-0.0098 (0.0020)	-0.0117 (0.0019)	-0.0102 (0.0020)	-0.0115 (0.0018)
Long-Run u_{jt}	-0.0264 (0.0033)	-0.0305 (0.0034)	-0.0278 (0.0034)	-0.0294 (0.0031)	-0.0223 (0.0046)	-0.0267 (0.0044)	-0.0233 (0.0047)	-0.0261 (0.0042)
Spatial u^*_{jt}	-0.0006 (0.0017)	0.0025 (0.0019)	-0.0003 (0.0017)	0.0017 (0.0017)	-0.0031 (0.0024)	0.0001 (0.0027)	-0.0023 (0.0025)	-0.0004 (0.0026)
IV (FE)								
W_{ijt-1}	0.5527 (0.0109)	0.5512 (0.0109)	0.5523 (0.0109)	0.5521 (0.0109)	0.5228 (0.0186)	0.5227 (0.0185)	0.5224 (0.0186)	0.5214 (0.0186)
Short-Run u_{jt}	-0.0175 (0.0030)	-0.0201 (0.0028)	-0.0183 (0.0031)	-0.0187 (0.0025)	-0.0154 (0.0052)	-0.0175 (0.0045)	-0.0155 (0.0054)	-0.0180 (0.0045)
Long-Run u_{jt}	-0.0391 (0.0065)	-0.0448 (0.0061)	-0.0409 (0.0071)	-0.0416 (0.0075)	-0.0322 (0.0107)	-0.0367 (0.0092)	-0.0324 (0.0109)	-0.0375 (0.0096)
Spatial u^*_{jt}	0.0020 (0.0034)	0.0064 (0.0038)	0.0032 (0.0036)	0.0043 (0.0031)	-0.0056 (0.0057)	-0.0026 (0.0060)	-0.0054 (0.0060)	-0.0031 (0.0050)

	5	6	7	8	9	10	11	12
	Typ2 G1	Typ2 G2	Typ2 G3	Typ2 G4	Typ3 G1	Typ3 G2	Typ3 G3	Typ3 G4
Fixed Effects								
W_{ijt-1}	0.5896 (0.0207)	0.5902 (0.0207)	0.5896 (0.0207)	0.5903 (0.0207)	0.5643 (0.0285)	0,5649 (0.0288)	0.5643 (0.0285)	0,5636 (0.0288)
Short-Run u_{jt}	-0.0130 (0.0021)	-0.0146 (0.0023)	-0.0137 (0.0021)	-0.0144 (0.0020)	-0.0098 (0.0023)	-0.0109 (0.0031)	-0.0098 (0.0032)	-0.0099 (0.0028)
Long-Run u_{jt}	-0.0318 (0.0050)	-0.0357 (0.0056)	-0.0335 (0.0052)	-0.0351 (0.0048)	-0.0224 (0.0073)	-0.0250 (0.0074)	-0.0226 (0.0075)	-0.0226 (0.0068)
Spatial u^*_{jt}	0.0009 (0.0025)	0.0041 (0.0030)	0.0020 (0.0026)	0.0040 (0.0026)	-0.0023 (0.0040)	-0.0002 (0.0045)	-0.0021 (0.0041)	-0.0026 (0.0040)
IV (FE)								
W_{ijt-1}	0.5758 (0.0161)	0.5743 (0.0162)	0.5751 (0.0162)	0.5753 (0.0161)	0.5144 (0.0260)	0.5194 (0.0261)	0.5153 (0.0260)	0.5170 (0.0260)
Short-Run u_{jt}	-0.0155 (0.0040)	-0.0170 (0.0039)	-0.0160 (0.0042)	-0.0163 (0.0033)	-0.0323 (0.0084)	-0.0358 (0.0080)	-0.0331 (0.0086)	-0.0322 (0.0073)
Long-Run u_{jt}	-0.0366 (0.0092)	-0.0400 (0.0090)	-0.0376 (0.0100)	-0.0384 (0.0095)	-0.0665 (0.0167)	-0.0744 (0.0161)	-0.0683 (0.0172)	-0.0667 (0.0168)
Spatial u^*_{jt}	0.0038 (0.0051)	0.0061 (0.0055)	0.0043 (0.0053)	0.0062 (0.0045)	0.0164 (0.0091)	0.0285 (0.0107)	0.0179 (0.0094)	0.0181 (0.0089)

In conclusion, Table 5 gives a robustness check with respect to four alternative choices of the weight matrix. The effect of spatial unemployment might depend on the special version of the spatial weight matrix used. Therefore, the matrix *G* is varied in these checks: *G1* is the contiguity weight matrix used in Tables 1-4. *G2* is based on commuting flows between regions, which is measured in relation to all employment in the respective target region. The proportion of commuters from one region to another is again row-normalised. This matrix gives linkages between regions which are farther apart, whereas G1 describes only adjacent neighbours. The matrix *G3* is calculated by using the inverse of geographical distance between regions. This measure is calculated for the adjacent neighbours and is set to zero for all regions which have no common border. Finally, in *G4*, regions that could be reached within an hour have a weight of 1 and all others a weight of 0. With *G3* and *G4* the regions are represented by their political centres which are mostly identical with the largest cities or towns of these regions.

Table 5 shows the results of some models as a direct comparison of the weight matrices applied. The results obtained on the basis of matrices *G1* to *G4* are quite stable. Only slight differences in the results are observed. For all region types, no weight matrix leads to significant spatial unemployment effects.

7. Conclusion

Using models with spatial interactions, this study reconsiders the empirical evidence on the western German wage curve. One main focus is the application of dynamic models which are augmented by a spatially weighted unemployment rate. In addition, central aspects concerning agglomeration effects and the differentiation between various subpopulations are considered. Our primary data base is the IAB Employment Sample (IABS) over the period 1980-2004. This micro data set allows us to control for individual unobserved heterogeneity.

We confirm the finding of a dynamic wage curve, i.e. a significant coefficient on lagged wages (about 0.55) that is far from unity. The wage elasticity with respect to unemployment is relatively small but significant (-0.016) in the short run and about double (-0.037) in the long run. We also find that this wage effect of unemployment is more pronounced for groups with weaker bargaining power, i.e. younger versus older workers, men versus women, foreigners versus native Germans. This corresponds closely to theoretical expectations.

Important results are obtained for different types of regions. It can be seen that the wage curve in the rural country is more elastic than that in core cities and large agglomerations. This can be attributed to the degree of monopsony in the labour market. In large agglomerations, firms have more competitors, whereas in the rural country the dependency of workers on single firms is more pronounced.

It is remarkable that the spatially weighted unemployment rate is only seldom important for the level of wages. In most of our results, only local unemployment influences wages. Again the rural country is a counterexample. While this is our finding for West Germany, spatial unemployment could be significant for other countries where wage negotiations and labour markets are different.

Data Appendix

The data set used in this study is a one percent random sample of the Employment Statistics which includes the total population of people gainfully employed and included in the social insurance system in western Germany. This is over 80% of all employment. The observation period is 1980-2004. The 25 waves of this panel include a total of 9,188,532 individual employment spells of people working full-time. The wage variable is measured for calendar days. It is deflated by the consumer price index calculated for western Germany by the German General Statistical Office.

One of the advantages of the employment statistics is the identification of the region where a specific employee is located. For our study, 326 administrative districts (Landkreise/ kreisfreie Städte) are used as regional units. Berlin is excluded because of its special situation as an “island” in Eastern Germany.

Originally, the data of the employment statistics were taken over for administrative purposes of the social security system and were collected by the Federal Employment Agency (Bundesagentur fuer Arbeit), see Bender, et al. (1996). Since they are used to calculate the pensions of retired people, the income and duration information is very reliable. No wage classifications are needed because the exact individual wage is reported. Apart from the individual wage, the following variables were used in our regressions:

- *Age.* Age of the individual.
- *Sex.* Female=1 and male=0.

- *Employment status*. This variable includes 6 categories: Unskilled blue collar, skilled blue collar, white collar, apprentice, foreman, no classification applicable.
- *Qualification level of an employee*. This variable includes 4 categories: No formal education, vocational qualification, university degree, no classification applicable.
- *Industry classification*. This variable defines the specific industry to which the employing establishment belongs. These include 30 categories like primary sector, energy & mining, motor vehicles, construction, trade, business related services, education, public administration, and not applicable.
- *Occupational group*. This variable describes the field of occupational specialization of an employee. These include 14 categories: agricultural, nonqualified blue collar worker, qualified blue collar worker, technician, engineer, simple services, qualified services, semi-professional, professional, simple administrative, qualified administrative, managers, special occupations of the former German Democratic Republic, and no classification applicable.
- *Establishment size*. The size of an establishment measured by the number of employees. This includes 9 categories. 1-4 employees, 5-9 employees, 10-49 employees, 50-99 employees, 100-199 employees, 200-499 employees, 500-999 employees, 1000-4999 employees, and more than 4999.
- *Regional unemployment:* The districts are the smallest regions for which unemployment figures can be obtained. Unemployment rates were computed by dividing this variable by the sum of regional total employment and unemployment.

The data we use is obtained from the standard IAB Employment Sample (IABS-reg01), which covers 2 % of all employment in the period of 1976 to 2001. The information basis was extended to cover also the recent years 2002-2004. We do not use data from the seventies because the regional information is not consistent with the one of later years.

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