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Inflation-Unemployment Tradeoff and Regional Labor Market Data

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Abstract

We estimate a linear and a piecewise linear Phillips curve model with regional labor market data for West German and Neue Länder. Employing regional observations allows us to country difference the data. This eliminates, under the assumption of homogeneous Länder, supply shocks and changes in the formation of expectations as possible identification failures. With seemingly unrelated regressions we find a flat Phillips curve in the Neue Länder. For the West German Länder a piecewise linear model with a higher inflation-unemployment tradeoff for the regime of low unemployment rates fits the data very well. The results hold true if we control for endogeneity of the unemployment rate. With a kinked but upward sloping aggregate supply curve there seems to be room for stabilization policies, at least in the range of aggregate demand shifts that our data covers.

Keywords: inflation-unemployment tradeoff, NAIRU, regional labor market data, seemingly unrelated regression
JEL-classification: E24, E31

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1 Introduction

More than three decades ago Milton Friedman (1968) argued that a 'natural rate of unemployment' would determine inflation in the long run. Any attempt to steer the economy below that rate of unemployment, sometimes also called the non-accelerating-inflation-rate-of-unemployment (NAIRU), would lead to increasing inflation rates while an unemployment rate higher than that would cause disinflation. By that time, it challenged the perception of the Phillips curve as some kind of a stable downward sloping relation in a scatter plot diagram with inflation and unemployment on the axes. Thirty years after, there is still no consensus view on whether monetary and fiscal policies have an effect on unemployment in the short as well as in the long run, only in the short run, or not at all. Even if one accepts Gregory Mankiw's proposition that one of the ten principles of economics is that monetary policy has an impact on inflation and unemployment in the short run there is still no agreement on how to explain an inflation-unemployment tradeoff (Mankiw 2000).

Some time series studies like Gordon (1997) find support for a time-varying NAIRU. But it has also been argued that supply shocks or changes in the way workers and firms form expectations caused the break down of the Phillips curve. Only recently, the role of expectations has been investigated by Akerlof, Dickens, and Perry (2000). They find a nonlinear Phillips curve with inflation regimes where there is a tradeoff and others where there is non because of regime specific inflation expectations.

In this paper we confront the inflation-unemployment tradeoff with regional labor market data on nominal wage inflation and unemployment for Germany. Drawing on regional observations for estimating an inflation-unemployment tradeoff has several advantages to studies of more aggregated time series (see also Coe et al. 1999, DiNardo and Moore 1999). As we have quarterly data on nine West German Länder and five Neue Länder for all through the nineties, our estimations are based on more than 200 observations for the West Länder and more than 100 observations for the Neue Länder. This large amount of observations also enables piecewise linear estimates of the Phillips curve for high and low regimes of unemployment. Regional data allows us, under the assumption of common shocks to all Länder, to eliminate supply side shocks by differencing our series with respect to one country. Therefore, we can circumvent the difficult choice of a supply side variable, that captures e.g. changing import prices or deviations of productivity growth from a trend. Finally, assuming that inflation expectations do not change differently across Länder, country differenced data allows us to eliminate changes in expectations formation as a possible reason of a break down of the inflation-unemployment tradeoff.

The rest of the paper is organized as follows. First, we sketch our Phillips curve models, a linear and a piecewise linear version, and define coefficient restrictions that we will employ to test the slopes of the inflation-unemployment tradeoff. Section 3 reports on the data and presents the empirical results. The last section summarizes and draws some conclusions with respect to stabilization policies.

2 Model

The standard approach for specifying a Phillips curve is to write actual wage inflation as a function of expected wage inflation and the unemployment rate. Taking lagged wage inflation as a proxy for expected wage inflation and considering various lags for both endogenous and exogenous variables one can formulate a Phillips curve model as

$$\pi_{k,t} = a_k + \sum_{i=0}^{4} b_i \cdot U_{k,t-i} + \sum_{j=1}^{4} c_j \cdot \pi_{k,t-j}, \qquad (1)$$
$$k = 1, 2, \ldots, K, \;\; t = 1, 2, \ldots, T,$$

where a_k are constants, $k = 1, 2, \ldots, K$, and the regional unemployment rates $U_{k,t}$ and wage inflation rates $\pi_{k,t}$ have up to four lags. The coefficients on the right hand side variables shall be the same for all K Länder. Only the intercept a_k can vary. The model takes the wage inflation rate as the endogenous variable. The causal relationship runs from lagged wage inflation rates as proxies for the expected wage inflation rate and unemployment to wage inflation.

Assuming that at some point in time all adjustment processes have worked themselves out ($U_k^* = U_{k,t} = U_{k,t-1} = ...$) and ($\pi_k^* = \pi_{k,t} = \pi_{k,t-1} = ...$) the Phillips curve relation follows from (1) as

$$\pi_k^* = \frac{a_k}{1 - \sum_{j=1}^{4} c_j} + \frac{\sum_{i=0}^{4} b_i}{1 - \sum_{j=1}^{4} c_j} \cdot U_k^*. \qquad (2)$$

From (2) follows that if the sum of the coefficients on the lagged wage inflation rates is equal to one, the Phillips curve is vertical (given the sum of coefficients on unemployment is not zero). In that case, one has a regional

NAIRU[1]

$$U_k^* = \frac{-a_k}{\sum_{i=0}^{5} b_i}. \tag{3}$$

Policies that would try to push unemployment below U_k^* would be punished by accelerating wage inflation rates. After a while, the economy would return to its "natural rate of unemployment", however, wage inflation rates would have stabilized at a higher level. Bringing wage inflation rates down again, would require that unemployment increases above the natural rate for a transitory period.

If one minus the sum of the coefficients on past wage inflation rates is positive, and the sum of coefficients on the unemployment rates is negative, the relationship between wage inflation and unemployment is downward sloping. In this case, e.g. an expansionary monetary policy would have an effect on wage inflation and unemployment, increasing the former and lowering the latter. The coefficient on U_k^* in (2), alas the slope of the Phillips curve, is usually taken as a proxy for the costs of the policy. Given that the denominator on U_k^* in (2) is different from zero, the Phillips curve would be flat if the numerator is zero. Finally, if the numerator is different from zero, and the denominator equals zero, the Phillips curve is vertical with a regional NAIRU's as given in equation (3).

The model (1) can be extended with a dummy variable distinguishing high and low unemployment regimes. This allows a piecewise linear specification for the Phillips curve,

$$\pi_{k,t} = a_k + \sum_{i=0}^{4} b_i \cdot U_{k,t-i} + \sum_{j=1}^{4} c_j \cdot \pi_{k,t-j} + dum_t \cdot \sum_{\ell=0}^{4} d_\ell \cdot U_{k,t-\ell}. \tag{4}$$

If the unemployment rate in period t is above average the dummy variable is one. Otherwise it is zero and equation (4) is identical to equation (1).

Usually a supply side variable is added to the right hand side of the specification to control for changing input prices, e.g. caused by oil price shocks, productivity growth above or below some trend, or changing demographics. To eliminate supply shocks we assume that those effects have been the same for all West German and Neue Länder, respectively. Then we can deal with supply side effects by differencing our data with respect to one Land (Ashenfelter 1984, DiNardo and Moore 1999).[2] For the West German Länder we

[1] If the sum of the estimated coefficients on the lagged wage inflation rates is significantly different from one, two alternative procedures have recently been considered to compute a NAIRU. First, one might impose this restriction prior to estimation; second, one might assume an inflation target of the central bank, see Franz (2001).

[2] We are aware that the assumption of homogeneous shocks across the Länder can be

difference our data with respect to Bayern, and for the Neue Länder we take Sachsen as the reference country. Thus, country differencing circumvents the difficult choice of a supply side variable for each Land. If one furthermore assumes that expectations are formed in the same way across Länder, country differencing also allows to eliminate changes in the formation of expectations as a possible failure to identify an inflation-unemployment tradeoff. Finally, in an economy where labor is mobile changing relative real wages in one area will attract workers from other areas. The labor supply response to changing real wages with mobility will be larger making the regional Phillips curve flatter than a nation wide Phillips curve. Several empirical studies on labor mobility (see Puhani 1999), however, indicate, that the response of workers to changing prices is exceptionally low, especially when compared to the U.S. Therefore, we think that given our short time span of ten years mobility will not blur our estimation results and we do not add a supply side variable for those reasons.

3 Empirical Results

3.1 Data

Unemployment rates are taken from the records of the Bundesanstalt für Arbeit. A wage inflation index is constructed by using average gross hourly wages for workers in the production sector. This data is reported in Fachserie 16 of the Statistische Bundesamt. The wage inflation index is defined as changes in average gross hourly earnings divided by average gross hourly earnings

$$\pi_t = \frac{W_t - W_{t-1}}{W_t}. \tag{5}$$

Thus, we construct a pool with quarterly data on unemployment rates and wage inflation for almost all German Länder[3] that covers the time period from 1991:3 to 1999:4.

problematic. For example, in case of considerably different industry structures, country differencing the data will not completely eliminate the impact of supply shocks, and country specific means a_k may not fully account for heterogeneity across countries. Nevertheless, country differencing the data may be superior to an arbitrary choice of a supply side variable.

[3] Data on unemployment rates for the whole time span was not available for Bremen and Berlin.

3.2 Unit root tests

Looking at the data in Figures 1 and 2, the wage inflation rates clearly appear stationary while the unemployment rates might be integrated of order one (nonstationary). In order to avoid an unbalanced regression of stationary series on nonstationary ones, we first have to establish that the unemployment rates $U_{k,t}$ can be considered as stationary, too. This could be done by means of recently developed panel unit root tests, confer the special edition of the Oxford Bulletin of Economics and Statistics edited by Banerjee (1999). Those tests, however, typically have to assume independent countries, which seems to be a bit heroic in case of our Länder. Therefore, we employ individual tests for each Land.

The standard Dickey-Fuller test relies on the model

$$\Delta U_{k,t} = c + (\rho - 1) \cdot U_{k,t-1} + e_t, \quad t = 2, 3, \ldots, T, \tag{6}$$

where Δ denotes the usual difference operator. The null hypothesis of a unit root is maintained for

$$H_0: \ \rho = 1.$$

The models are estimated by ordinary least squares (OLS), and the null hypothesis is rejected in favor of stationarity for too negative t-statistics testing for $\rho - 1 = 0$. In case of serial autocorrelation of the error term e_t, equation (6) has to be augmented with lagged differences. Throughout we included only $\Delta U_{k,t-1}$ and $\Delta U_{k,t-4}$, which yielded empirically uncorrelated residuals. Such a parsimonious specification was chosen in order not to waste power. Alternatively to augmenting the Dickey-Fuller regression, the t-statistics from (6) can be corrected for residual autocorrelation, see Phillips (1987) and Phillips and Perron (1988). This nonparametric correction requires the estimation of the so-called long-run variance, which is usually done by means of the Bartlett window, where the bandwidth m of the window has to be chosen by the user. Two popular choices in practice have been introduced by Schwert (1989):

$$m_4 = \text{int}\left\{4 \cdot \left(\frac{T}{100}\right)^{0.25}\right\}, \quad m_{12} = \text{int}\left\{12 \cdot \left(\frac{T}{100}\right)^{0.25}\right\}.$$

Table 1 summarizes the empirical findings[4] of the augmented Dickey-Fuller (ADF) and Phillips-Perron tests, $PP(m_i)$. For the Western Länder the overall evidence is against a unit root. The PP tests always reject at least at the

[4]All computations for this paper were performed with the help of *Eviews*.

5% level (with the exception of Schleswig-Holstein), although the ADF test produces slightly less significant results. With Schleswig-Holstein (SCH) we get at least close to the 10% significance level. For the Neue Länder, however, the results are very different. None of the test statistics is significant at the 10% level. We also run the regression (6) with an additional time trend, thus testing "integrated with drift" against the alternative hypothesis of trendstationarity. But this did not produce significant test statistics either.

Hence, when it comes to systems estimation in the next subsection, it will be assumed that the unemployment rates of the Western Länder can be considered as stationary, while this does not seem to be the case with the Neue Länder. Therefore, the regression for the Neue Länder will be partly unbalanced in the following sense: Stationary wage inflation rates with finite variance cannot be explained by nonstationary unemployment rates where the variance is growing with time. That's why a flat Phillips curve, $b_0 + b_1 + b_2 + b_3 + b_4 = 0$, has to be expected for the Neue Länder from an econometric point of view.

3.3 Linear model

With $T = 34$ quarterly observations and $K = 8$ West German and $K = 4$ Neue Länder we are not confronted with the typical panel situation of many individuals and only few observations over time. Therefore, our econometric methododology relies on a classical dynamic systems approach. Throughout, we estimate separate systems for the West German and the Neue Länder, and indeed, the results for West Germany differ from those for the East.

First, (1) was estimated simply by OLS. However, instead of allowing for individually varying constants a_k, we considered individually varying quarterly means $s_{i,k}$ with $\sum_{i=1}^{4} s_{i,k} \cdot \delta_{i,t}$, where $\delta_{i,t}$ are usual seasonal dummy variables (i.e. equal to one if t falls into the ith quarter and zero otherwise). From the residuals we obtained contemporaneous correlations r_{kj} between Land k and j to compute the Breusch-Pagan statistic

$$BP = T \cdot \sum_{k=2}^{K} \sum_{j=1}^{k-1} r_{kj}^2.$$

The null hypothesis is that all individuals (Länder) are independent of each other, while under the alternative hypothesis the errors from at least two equations correlate. For large T, BP can be approximated by a χ^2 distribution with $K \cdot (K-1)\,/\,2$ degrees of freedom, see Breusch and Pagan (1980).

Table 1: Unit root tests of unemployment rates

	ADF	$PP(3)$	$PP(9)$
West German Länder			
BAD	-2.32 $(-)$	-5.15 $**$	-5.14 $**$
HAM	-2.92 $*$	-2.90 $*$	-3.58 $**$
HES	-1.67 $(-)$	-3.47 $**$	-4.18 $**$
NIE	-3.04 $*$	-3.05 $*$	-3.76 $**$
NOR	-2.50 $(-)$	-5.79 $**$	-5.45 $**$
RHE	-2.47 $(-)$	-3.66 $**$	-4.18 $**$
SAA	-3.96 $**$	-4.82 $**$	-4.81 $**$
SCH	-2.33 $(-)$	-1.94 $(-)$	-2.53 $(-)$
Neue Länder			
BRA	-2.23 $(-)$	-2.41 $(-)$	-2.17 $(-)$
MEC	-2.18 $(-)$	-1.46 $(-)$	-1.42 $(-)$
SAT	-1.97 $(-)$	-1.86 $(-)$	-1.81 $(-)$
THU	-1.14 $(-)$	-0.58 $(-)$	-0.63 $(-)$

$**$, $*$, and $(*)$ denote 1%, 5%, and 10% significance, respectively, while $(-)$ stands for significance only at a lower level. Reported are t-statistics of augmented Dickey-Fuller and Phillips-Perron tests. The bandwidth for the latter test was chosen as $m_4 = 3$ and $m_{12} = 9$.

BAD=Baden-Württemberg, HAM=Hamburg, HES=Hessen, NIE=Niedersachsen, NOR=Nordrhein-Westfalen, RHE=Rheinland-Pfalz, SAA=Saarland, SCH=Schleswig-Holstein, BRA=Brandenburg, MEC=Mecklenburg-Vorpommern, SAT=Sachsen-Anhalt, THU=Thüringen

The values for the West German and Neue Länder are $110.656 > \chi^2_{0.995}(28)$ and $14.912 > \chi^2_{0.975}(6)$, respectively, which clearly allows to reject the null hypothesis of independent Länder. Therefore, we have systems of seemingly unrelated regressions (SUR) that should be estimated by GLS (Generalized Least Squares), see Zellner (1962), to obtain efficient estimators and approximately valid standard inference.

Next, we estimated model (1) as SUR (again with seasonal dummies, see above). Notice that the lagged endogenous variables may give rise to a finite sample bias (see e.g. Nickell 1981), which, however, decreases with T and is hence negligible in our application with T being a multiple of K. In Table 2 we present the estimates with t-values in brackets.

Table 2: Regression results for the linear model, SUR

West German Länder								
b_0	b_1	b_2	b_3	b_4	c_1	c_2	c_3	c_4
0.0031	-0.0049	0.0025	0.0020	-0.0033	-0.39	-0.28	-0.10	-0.07
(1.498)	(-1.715)	(0.887)	(0.716)	(-1.614)	(-6.118)	(-4.279)	(-1.443)	(-1.066)
$H_0: \ b_0 + b_1 + b_2 + b_3 + b_4 = 0$					$H_0: \ c_1 + c_2 + c_3 + c_4 = 1$			
$\chi^2 = 0.312$ (0.576)					$\chi^2 = 110.35$ (0.000)			

Neue Länder								
b_0	b_1	b_2	b_3	b_4	c_1	c_2	c_3	c_4
0.0010	-0.0033	0.0041	-0.0006	-0.0024	-0.25	0.06	-0.08	0.06
(0.487)	(-1.219)	(1.573)	(-0.250)	(-1.193)	(-2.761)	(0.760)	(-0.910)	(0.738)
$H_0: \ b_0 + b_1 + b_2 + b_3 + b_4 = 0$					$H_0: \ c_1 + c_2 + c_3 + c_4 = 1$			
$\chi^2 = 1.417$ (0.234)					$\chi^2 = 34.764$ (0.000)			

SUR estimation of model (1) (with seasonally varying intercepts) with t-values in brackets. The restrictions on the coefficients are tested with Wald tests: χ^2 gives the value of the statistics (with p-values in brackets).

The coefficients on the lagged wage inflation rate for the first two quarters are significant for the Western Länder. The null hypothesis of a vertical Phillips curve, $c_1 + c_2 + c_3 + c_4 = 1$, is rejected at any arbitrarily small significance level; we report the value of the Wald statistic χ^2 (with p-value in brackets). The coefficients on the unemployment rate variables are not significantly different from zero if tested with individual t-statistics, which would imply a flat Phillips curve. In addition, we tested the null hypothesis that the Phillips curve is flat as a restriction on the coefficients, $b_0 + b_1 + b_2 + b_3 + b_4 = 0$. The corresponding Wald type χ^2 statistic has a p-value of 0.576, which does not allow to reject the null hyptothesis at any reasonable level.

For the Neue Länder only the coefficient on the endogenous variable lagged for one period is significant. Apart from this, the results are qualitatively the same as for the Western Länder.

Of course, the GLS estimator might suffer from a bias due to endogeneity of $U_{k,t}$. Therefore, we instrumented the contemporaneous unemployment rate with the unemployment rate lagged for five periods and run three stage least squares (3-SLS) regressions. None of the coefficients on the unemployment rate became significant, neither for the West German Länder nor the Neue Länder, even after eliminating right hand variables succuessively.

Another source for the insignificance of the estimates of b_i might arise from the fact that the restriction of identical coefficients b_i and c_j over the Länder in model (1) is not justified. Let us abort this assumption for the moment. We hence allowed all coefficients to vary individually. Then we estimated this unrestricted system again by 3-SLS with instruments as described above. Nevertheless, for none of the eight Western Länder we could reject the null $b_{k,0} + b_{k,1} + b_{k,2} + b_{k,3} + b_{k,4} = 0$ of individually flat Phillips curves at the 5% level. The same approach with the Neue Länder rejected the null hypothesis of individually flat Phillips curves only for Sachsen-Anhalt; however, given the partly unbalanced model with nonstationary unemployment rates in East Germany this test result does not seem to be very reliable.

To sum up: So far the empirical findings suggest a flat Phillips curve as long as we restrict the empirical analysis to the linear model (1). For the Western Länder, however, a different picture emerges if we allow for different coefficients depending on high or low unemployment regimes.

3.4 Piecewise linear model

Now, we estimated model (4) as as system of seemingly unrelated regressions (SUR) (allowing again for seasonally varying intercepts). The dummy variable dum_t was generated as follows. First, we averaged over all West and East German Länder, $\overline{U}_t = \frac{1}{K} \cdot \sum_{k=1}^{K} U_{k,t}$, respectively. Then, we regressed this mean on seasonal dummies. Finally, dum_t equals one, if the residuals of that regression are positive, and equals zero otherwise. Hence, if the unemployment rate in period t is above average the dummy variable is one, otherwise it is zero.

The estimation method applied from the beginning was GLS. Variables with insignificant coefficients were eliminated successively, until we ended up with the reduced piecewise linear model. Parameter estimates (with t-values in brackets) are presented in Table 3 for West German Länder. Further, we test the null hypothesis that the Phillips curve is flat in the low unemployment regime ($b_1 + b_2 + b_4 = 0$) and in the high unemployment regime ($b_1 + b_2 + b_4 + d_0 + d_1 = 0$). The corresponding p-values of the Wald statistics χ^2 are again reported in brackets. In case of low unemployment we can reject the null hypothesis of a flat Phillips curve at the 5% level, while in the second case the χ^2 statistic is not significant at a usual level. At the same time, the null hypothesis that the coefficients of lagged wage inflation rates sum up to one (vertical Phillips curve) is clearly rejected.

Table 3: Regression results for the reduced piecewise linear model, SUR

West German Länder						
b_1	b_2	b_4	d_0	d_2	c_1	c_2
-0.0034 (-1.622)	0.0057 (2.213)	-0.0043 (-2.860)	0.0022 (2.911)	-0.0015 (-1.953)	-0.37 (-6.050)	-0.25 (-4.195)
$H_{01}:\ b_1 + b_2 + b_4 = 0$ $\chi^2 = 4.103$ (0.043) $H_{02}:\ b_1 + b_2 + b_4 + d_0 + d_1 = 0$ $\chi^2 = 1.988$ (0.159)					$H_0:\ c_1 + c_2 = 1$ $\chi^2 = 282.097$ (0.000)	

SUR estimation of model (4) (with seasonally varying intercepts) with t-values in brackets. The restrictions on the coefficients are tested with Wald tests: χ^2 gives the value of the test statistics (with p-values in brackets).

To robustify our results against an eventual endogeneity bias we redid the same exercise by 3-SLS estimation. The instrument for the contemporaneous unemployment rate is $U_{k,t-5}$. After reducing the model by successively eliminating insignificant variables, we end up with the estimates presented in Table 4. The final specification is slightly different from the one obtained by the SUR estimation, see Table 3. In particular, now the null hypothesis of a flat Phillips curve is rejected for low as well as for high unemployment regimes.

Table 4: Regression results for the reduced piecewise linear model, 3-SLS

West German Länder					
b_0	b_1	d_0	d_4	c_1	c_2
-0.0123 (-3.527)	0.0091 (2.900)	0.0093 (4.092)	-0.0083 (-3.717)	-0.40 (-6.345)	-0.29 (-4.762)
$H_{01}: \; b_0 + b_1 = 0$ $\chi^2 = 9.169$ (0.002) $H_{02}: \; b_0 + b_1 + d_0 + d_4 = 0$ $\chi^2 = 5.202$ (0.023)				$H_0: \; c_1 + c_2 = 1$ $\chi^2 = 296.169$ (0.000)	

3-SLS estimation of model (4) (with seasonally varying intercepts) with t-values in brackets. The restrictions on the coefficients are tested with Wald tests: χ^2 gives the value of the test statistics (with p-values in brackets).

The specifications in Table 3 and 4 were checked by testing for serial residual correlation. We employed the F type Lagrange Multiplier (LM) statistic building on 4 residual autocorrelation coefficients. The residuals of each equation from (4) were checked seperately. The test statistics (with p-values in brackets) for the West German Länder are collected in Table 5. Throughout we observe very insignificant LM statistics that do not allow to reject the null hypothesis of residuals free of autocorrelation, with one single exception: The residuals for the Saarland (SAA) display a moving average structure (MA(3)) that could not be removed by means of lagged endogenous or exogenous variables. Nevertheless, the overall impression is that our specifications are valid in terms of autocorrelated residuals.

For the Neue Länder the piecewise linear model (4) was not successful. Neither by GLS nor by 3-SLS estimation the coefficients d_ℓ were significantly different from zero. The regressions essentially reproduced the estimates given already in Table 2 with insignificant coefficients on the unemployment rates. Given the nonstationarity of the country differenced unemployment rates as established by the unit roots, this is not surprising because trending series cannot explain stationary inflation rates.

For the West German Länder we partly found evidence against a flat Phillips curve from model (4). This justifies to compute the tradeoff coef-

Table 5: LM tests for serial residual correlation

West German Länder, reduced piecewise linear model								
Land	*BAD*	*HAM*	*HES*	*NIE*	*NOR*	*RHE*	*SAA*	*SCH*
SUR	0.1184	0.747	0.430	0.568	1.659	0.664	2.596	0.497
	(0.944)	(0.570)	(0.786)	(0.688)	(0.191)	(0.623)	(0.061)	(0.738)
3-SLS	0.249	1.132	0.184	0.678	0.404	0.563	3.383	0.511
	(0.908)	(0.364)	(0.944)	(0.613)	(0.804)	(0.691)	(0.024)	(0.728)

LM statistic building on 4 residual autocorrelation coefficients of the models from Table 3 (SUR) and Table 4 (3-SLS) (p-values in brackets).

ficient from (2). Summing up the coefficients on the unemployment rates, b_i (and d_ℓ), and the lagged wage inflation rates, c_j, we get a tradeoff for the West German Länder of -0.12 if we are in the low unemployment regime and a flat Phillips curve in the high unemployment regime for the seemingly unrelated regression, see also Table 6. Hence, the Phillips curve has a kink and a one percentage point drop in the unemployment rate brings a 0.12 percentage point increase in the wage inflation rate in the low unemployment regime, while wage inflation rates would not change in the high unemployment regime. With the 3-SLS estimation the Phillips curve is also downward sloping in the high unemployment regime. Compared to the results from the SUR, wage inflation increases more with a drop of the unemployment rate in the low unemployment regime. Furthermore, the Phillips curve is also significantly downward sloping in the high unemployment regime. For the Neue Länder the linear as well as the piecewise linear specification yielded a flat Phillips curve, probably for reasons of instationary country differenced unemployment rates as was mentioned above.

4 Conclusions

We estimated a linear and piecewise linear Phillips curve model with regional labor market data from Germany. Employing regional data has the advantage that we can draw on more than 100 observations for our estimates of

Table 6: Inflation-unemployment tradeoff[(a)]

West German Länder		
	low U's	high U's
SUR	-0.12	-0.08[(b)]
3-SLS	-0.19	-0.13
Neue Länder		
3-SLS	-[(c)]	

(a) This is the coefficient on U_k^* in equation (2). As data on unemployment rates is given in % and wage inflation rates not, the coefficient is multiplied with a factor 100 to ease the interpretation of the tradeoff.

(b) The sum of coefficients on the unemployment rates is not significantly different from zero (see Table 3).

(c) None of the coefficients on the unemployment rate is significantly different from zero in this model.

the model for the Neue Länder and almost 250 observations for the West German Länder model although only a time span of 10 years is covered. Under the assumption of homogeneity of all West German and Neue Länder, respectively, one can eliminate supply shocks by country differencing. This circumvents the difficult choice of a supply shock variable. Furthermore, and under the same assumption, one can also exclude changes in the way agents form expectations as a possible identification failure. Finally, it has been shown for many OECD countries that unemployment rates have a unit root, at least if we consider the last three decades. Hence, differencing the data with respect to one country may also serve as a way to avoid an unbalanced regression. In our case, we can reject nonstationarity for the West German Länder but not for the Neue Länder after taking country differences. The unbalanced regression for the Neue Länder data may also explain why we find a flat Phillips curve, here. For the case of the West German Länder a piecewise linear model estimated as seemingly unrelated regressions fits the data very well. The results hold true if we instrument the unemployment rate to control for endogeneity. In both cases, the inflation-unemployment tradeoff is steeper in the regime of low unemployment rates than in the regime of high unemployment rates. For the 3-SLS model we get an inflation-unemployment tradeoff with quarterly data of -0.13 in the high unemployment regime and of -0.19 in the low unemployment regime. Hence, our results imply that the aggregate supply curve is upward sloping and kinked. It follows that at least in the range of shifts in aggregate demand that our data covers, monetary and fiscal policies may be used to stabilize the business cycle. However, the inflationary pressure rises with lower unemployment rates.

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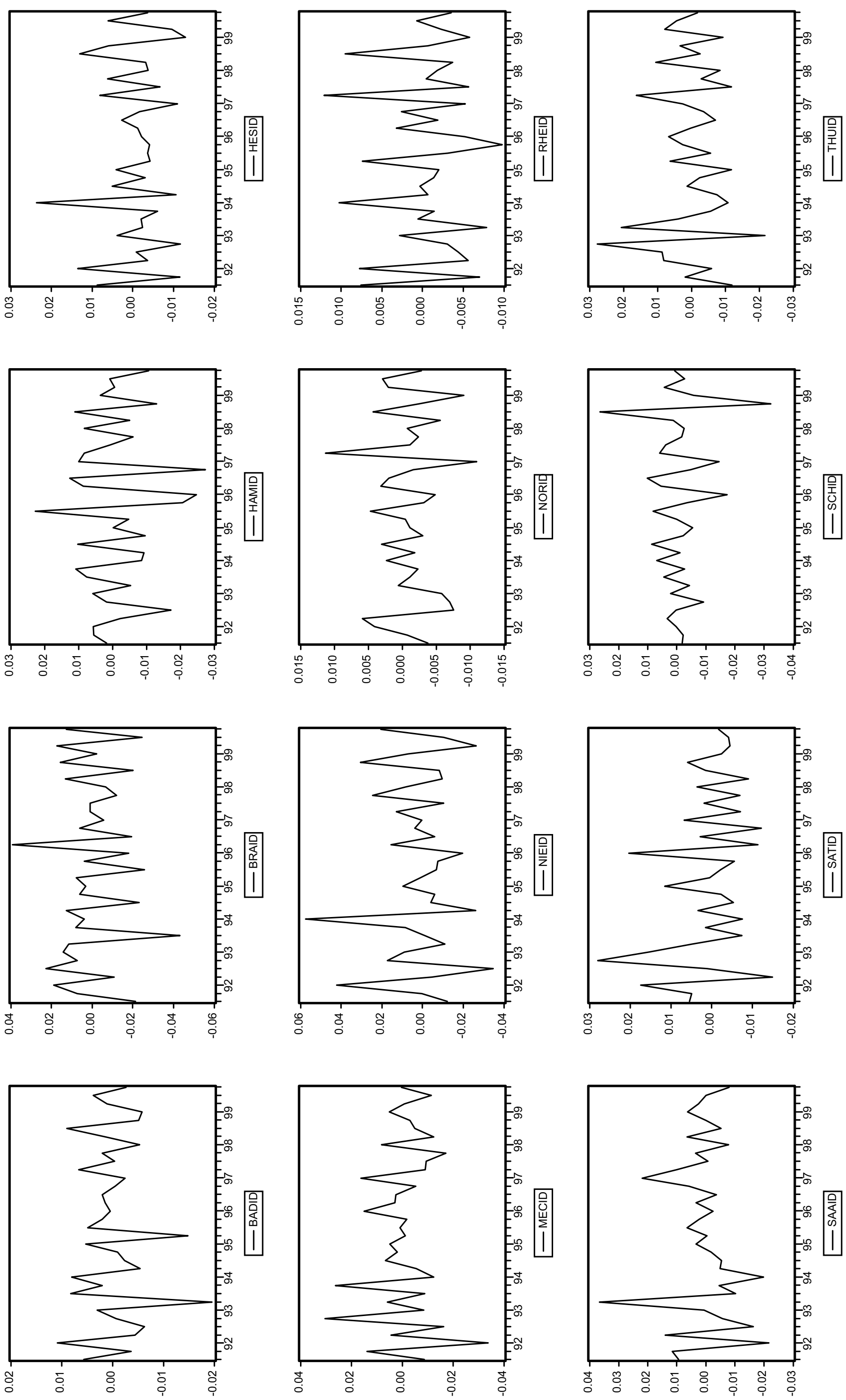

Figure 1: Country differenced wage inflation rates

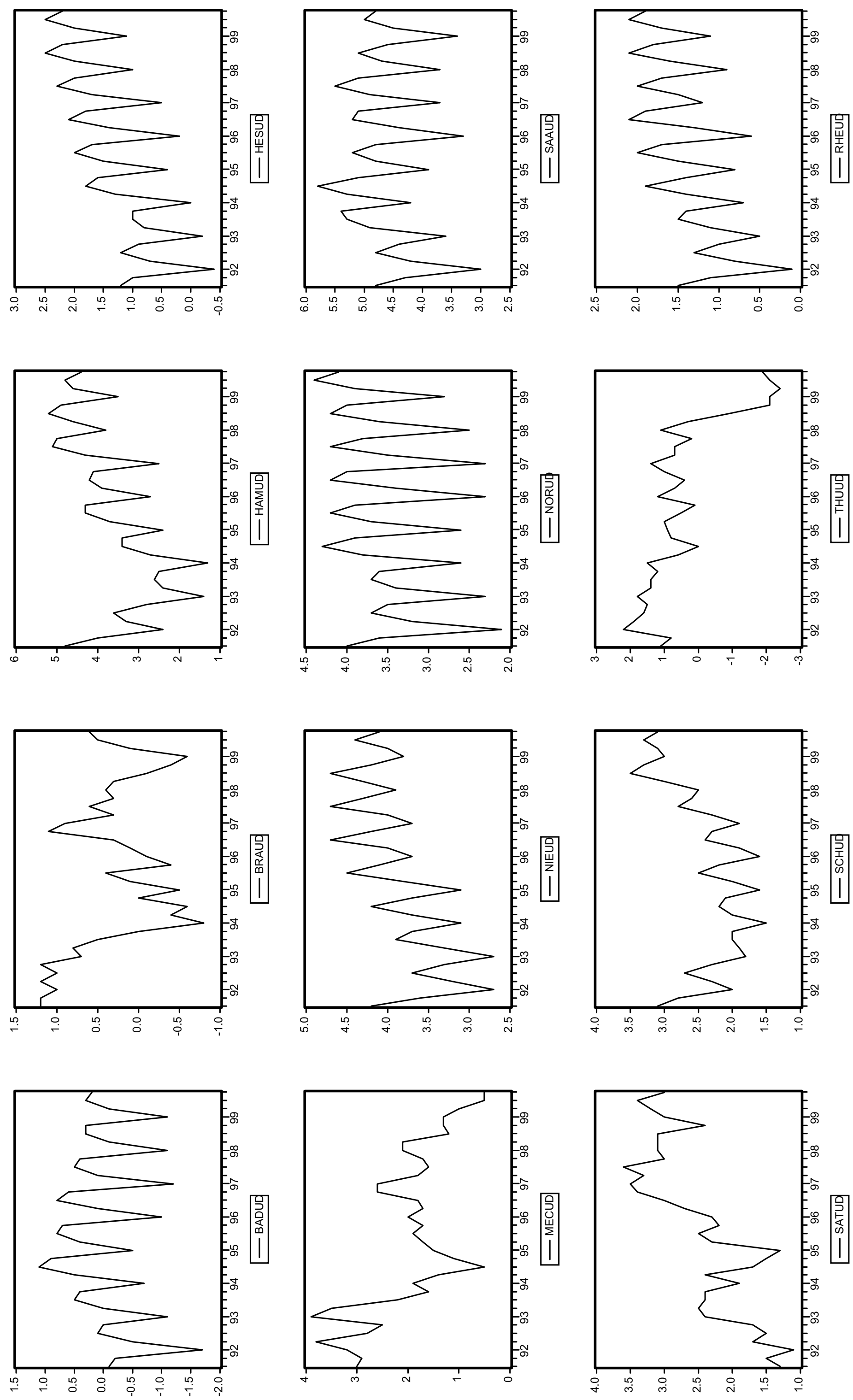

Figure 2: Country differenced unemployment rates

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