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## Do Employment Thresholds Vary Over Time? A Time Series Analysis Of The Relations Between Regional Unemployment And Output

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**ERSA**  
**40<sup>th</sup> European Congress**  
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**Do Employment-Thresholds vary over Time? A Time Series Analyses  
of the Relations between Regional Unemployment and Output**

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## **0. Summary**

Within an environment of permanent high unemployment economic forecasts of output variations are especially discussed with respect to the effects of economic growth on employment. Recent studies of the German labour market indicate that only output growth rates up to two per cent over several years yield a worth mentioning increase in employment. This relevant growth rate is called the employment threshold and denotes that growth rate, that is compatible with an unchanging situation of the labour market. The paper focuses on the question about the stability of this growth-employment-relationship in the context of a North Rhine-Westphalian Region over the last twenty years. Results of recursive estimation procedures are shown and are confronted with indicators of structural change for the sub regions of the district of the Chamber of Industry and Commerce of the Middle Lower-Rhine.

## **1. Background, Aim and Contents**

Published news about production and employment forecasts, at least in Germany, is often focused on the question, whether production growth is sufficient to cause a significant employment growth rate or a reduction in unemployment, respectively. Newspaper headlines of the kind “Business cycle recovery fails a substantial improvement of the labour market” indicate, that during the last years production growth rates have been too low to create more new jobs than jobs have been lost. There are in general two effects, which have to be separated in this context. The first is the “business cycle-effect” of short-term employment variations, caused by short-term production changes. The second effect is that of job creation and abolition of jobs within the long-term process of structural change (“structural effect”). The data of employment developments contain both effects, which overlaps each other in a more or less extent. The dominance of the one or the other effect is determined by the business-cycle phase of the economy and the intensity of the process of structural change. If we take the spatial view of the problem which is in question, the sectoral structure of the regional economy determines the net-effect with respect to employment changes, too. This structure is characterised by the relative importance of business-cycle dependent sectors on the one hand and that of those sectors, which have been faced with the effects of structural change on the other hand.

In the following business cycle and structural effects of production developments on employment –called as cycle and structure-components of employment - are estimated for the sub-regions of the Middle Lower Rhine and compared with the figures of North-Rhine-Westphalia. We use time series data for the years 1980 to 1995 to identify the importance of both effects/components and to calculate regional and sectoral specific employment-thresholds. The latter indicates that production growth rate, which would have induced a significant growth of employment. Using a recursive estimation procedure additionally, business cycle and structural effects as well as threshold values can be calculated as time series to answer the question, whether they vary significantly over time.

The paper is organised as follows: The next chapter contains some theoretical considerations about the decomposition of the two effects of production on employment mentioned above, and the deviation of the corresponding equation to be estimated. Within this chapter an estimation procedure, which allows for time varying coefficient estimations, is also introduced. The third chapter discusses empirical findings about the analysed region of the Middle Lower Rhine. Estimation results with respect to average values of the components of employment and the average employment-thresholds, calculated on the basis of these components, are shown in chapter four. At the end of this chapter the question of time-varying thresholds at the Lower-Rhine will be answered. The paper ends with some suggestions for further research.

## **2. Theoretical Considerations**

### **2.1. The Relationship between Employment and Growth**

The basis of the analysis is a simple causal relationship between employment and production. Because production often is used as the cycle-variable, which determines short-term fluctuations of employment, a trend-variable was added to the equation to introduce long-term structural change effects on employment:

$$(1) \quad E_{ijt} = a_0 + a_1 GVA_{ijt} + a_2 T_{ijt}$$

with:

E: employment

GVA: gross value added as an indicator for regional production figures

T: trend

i: region

j: sector

t: time.

There are some reasons to transform the levels of the variables in equation (1) into growth rates, so that we have the following equation (GR: growth-rate operator):

$$(2) \quad GR(E_{ijt}) = a_1 GR(GVA_{ijt}) + a_2$$

The first reason is that we get the corresponding coefficients as elasticities<sup>1</sup>. Whereas  $a_1$  is the production elasticity of employment and can be interpreted as the cycle-effect,  $a_2$  represents the autonomous growth of employment and can be designated as the structure-effect. If we take equation (2) as the estimation model there is a second reason. The possible spurious correlation between the levels of employment and production and the additional collinearity between the production level and the trend variable leads to estimation problems (spurious regression). These problems can be solved by using the growth rate-transformation, so that the resulting estimated coefficients are more robust ones in that sense, that we can believe on causal relationships looking at the coefficient estimations.

Using the estimated coefficients  $\hat{a}_1$  and  $\hat{a}_2$  we can calculate cyclical and structural components of employment as follows:

$$(3) \quad M[GR(E_{ijt})] = \underbrace{\hat{a}_1 \cdot M[GR(GVA_{ijt})]}_{\text{cyclical component}} + \underbrace{\hat{a}_2}_{\text{structural component}} + \underbrace{M[u_t]}_{\text{residual component}}$$

If we use the OLS estimation procedure, the estimated coefficients can be interpreted as average values for the entire period of the analyses. So the average ( $M$  = mean operator) growth rate of employment can be decomposed into the means of cycle-caused growth, autonomous growth (caused by structural change) and a residual component. At least with respect to the average view of equation (3) the estimation procedure will yield  $M[u_t] = 0$ ! But it will be interesting to look at the residuals, if time varying parameters are used later on in the following.

There is another figure, which can be deviated from equation (3), what is the employment threshold. How it was mentioned above, this value indicates that production growth rate, from which on employment increases. It can be calculated by setting  $M[GR(E_{ijt})] = 0$  and then resolved regarding  $M[GR(GVA_{ijt})]$ :

$$(4) \quad \text{Employment-Threshold: } M[GR(GVA_{ijt})] = \frac{-a_2}{a_1}$$

As equation (4) shows, the threshold is defined as the quotient of structural effect and cycle effect. If we have a negative structural effect, the nominator will get a positive sign. In this case the threshold value shows the necessary positive production growth rate, what will cause unchanged employment figures<sup>2</sup>. The higher the value of the nominator in relation to the denominator is, the higher production growth rates within a business cycle upturn are needed for compensation.

Another interpretation of the employment-threshold is based on the study of P.J.Verdoorn (1951): The threshold is that growth rate of production, that equalises production growth and productivity growth. The causal relation is based on the definition of production changes as the sum of changes in employment and changes of employment productivity. In that case the structural effect in eq. (3) can be interpreted as the change of labour productivity. If we find a negative structural effect, then productivity growth has taken place and vice versa.

Getting the spatial view in combination with structural aspects, the employment-threshold should be relatively high in those regions, where “old” industries - which are faced with considerable requests of structural change - are still playing an important role. There the long-term slowdown of employment only could (of course only temporarily) be compensated by relatively high increases in cyclical caused production. If a region has been more or less successful with respect to the creation of a “modern” sector structure, the threshold values should be relatively small.

## 2.2. Recursive Least Squares, Time Varying Components and Thresholds

If we want to answer the question, whether there have been significant changes of the components of employment growth and the relating threshold values, we need to use a procedure which allows for time varying parameter estimations. Such a procedure is the Recursive Least Squares (RLS) method. The basic idea of this method is, upon a basic estimation period to enlarge this period successively about one unit. The estimation only will yield varying parameter values, if the new information of the added time period ( $x_t, y_t$  in eq. (5)) contains significantly different news about the relationships of the variables in question. The RLS estimator of the vector of time varying coefficients  $\mathbf{a}_t$  is defined as<sup>3</sup>:

$$(5) \quad \hat{\mathbf{a}}_t = (\mathbf{X}'_t \mathbf{X}_t)^{-1} (\mathbf{X}'_{t-1} \mathbf{y}_{t-1} + \mathbf{X}_t \mathbf{y}_t)$$

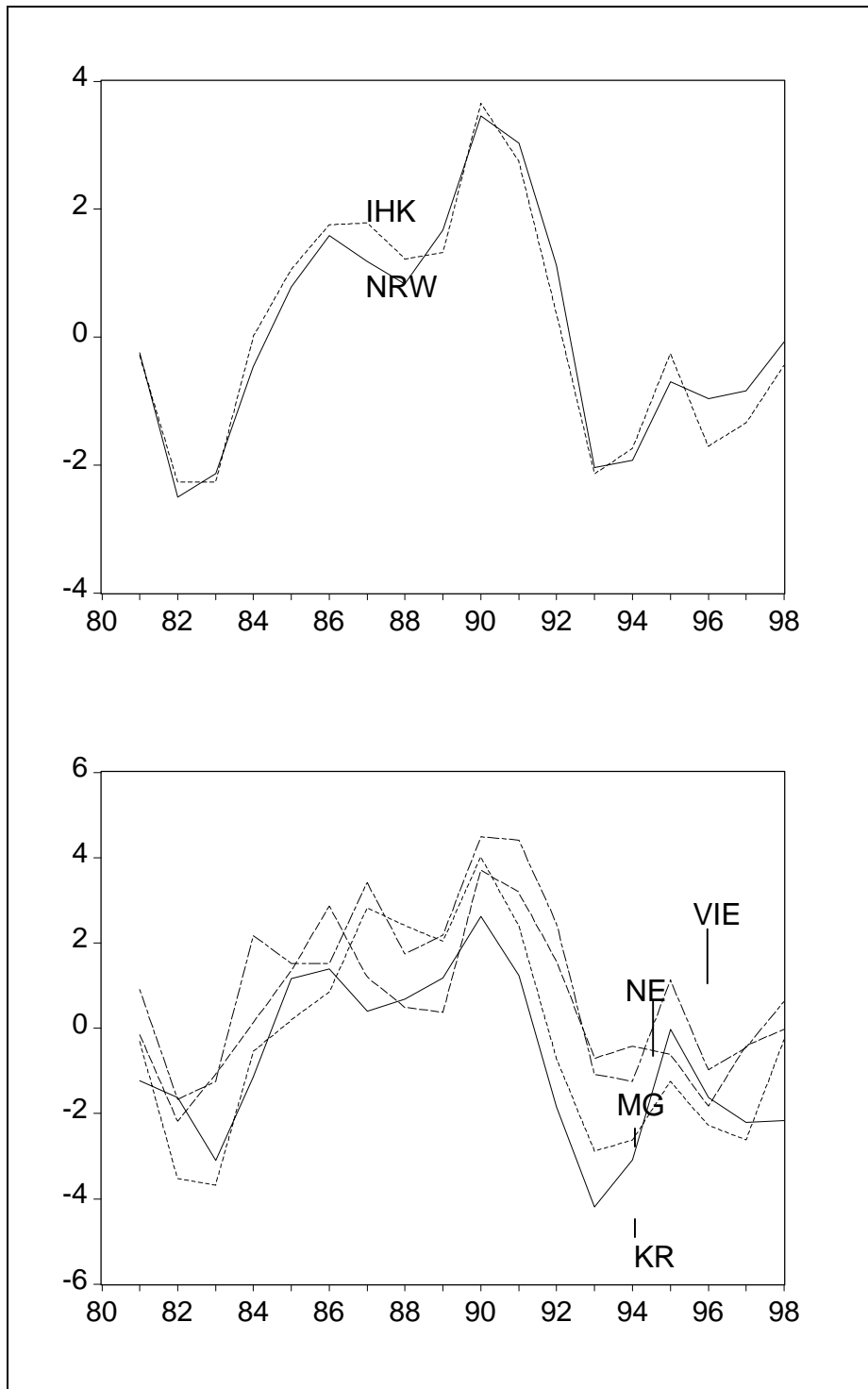
Using the results of the RLS estimations, we can calculate time varying employment growth components and employment thresholds as follows:

$$(6) \quad \text{GR}(E_{ijt})_t = \underbrace{\hat{a}_{1,t} \cdot \text{GR}(GVA_{ijt})_t}_{\text{cyclical component}} + \underbrace{\hat{a}_{2,t}}_{\text{structural component}} + \underbrace{u_t}_{\text{residual component}}$$

$$(7) \quad \text{Employment-Threshold: } \text{GR}(GVA_{ijt})_t = \frac{-a_{2,t} - u_t}{a_{1,t}}$$

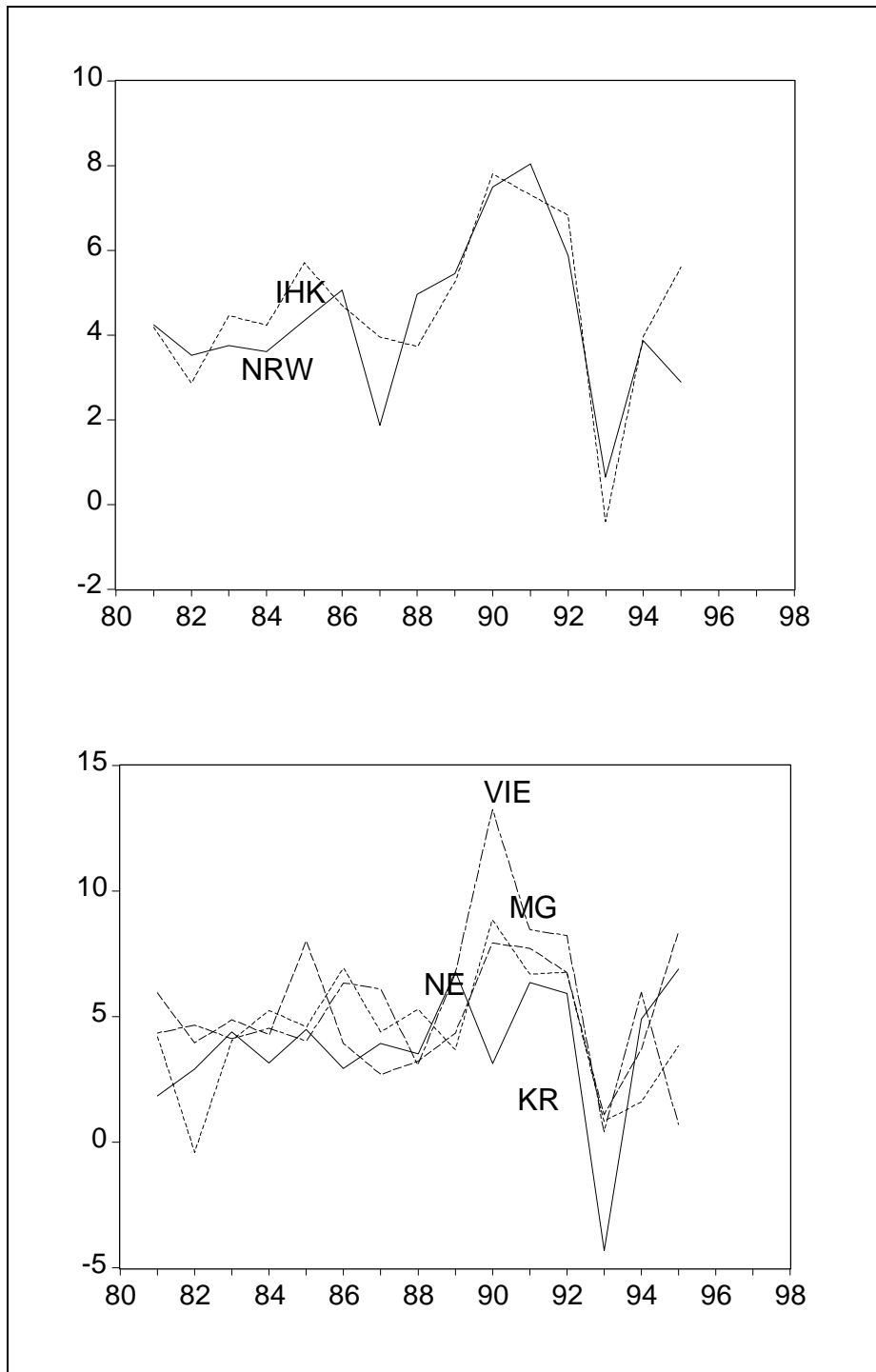
In opposite to the average views of equation (3) and (4) the values of the residual effects do matter looking at equation (6) and (7). Of course regarding the estimation of the relationship between employment and production the values of  $u_t$  have to be “white noise”, but with respect to the (“adding up”) definition of employment growth components they could be interpreted as “other” region specific determinants of employment growth.

**Figure 1: Employment in NRW and the CIC-District Middle Lower Rhine - Changes in %**





**Figure 2: Output in NRW and the CIC-District Middle Lower-Rhine**  
- Changes in %



### **3. Employment and Output - Some Empirical Findings for the Middle Lower Rhine**

Looking at Figure 1, no worth mentioning differences of employment changes between the average of NRW and the Chamber of Industry and Commerce-District Middle Lower Rhine (CIC-District) can be found. Within the CIC-District of course the relatively unfavourable development of employment regarding Krefeld, and in opposite to that, the favourable situation for Viersen are shown obviously. Detailed analysis of employment structures have been proved (Hamm and Wenke 1999, pp. 8ff.), that Krefeld has lost jobs especially in the industrial sector (1980-92: -9,8 %, 1992-98: -24%) and could get only little compensation from employment gains in the service sector (1980-92: +11,3%, 1992-98: -0,5%). In Viersen, moderate employment gains and losses respectively in the industrial sector (1980-92: +6,5%), 1992-1998: -14,6%) where combined with considerable employment gains in the service sector (1980-92: +46,7%, 1992-98: +10%). Despite these structural differences of employment changes, Figure 1 shows a comparable cyclical behaviour of the time series.

There are the considerable employment losses during the 1982 and 1993-recessions and the employment upswings of 1986 and especially 1990/1991, the latter as the well known result of the economic effects of German unification. There is no surprise looking at the relative performances of output development of NRW and the CIC-District, shown in Figure 2: Structural ranking of long term development as well as the cyclical behaviour of gross value added as an indicator of (nominal) production are similar to those of employment mentioned above.

### **4. Estimation Results**

#### **4.1. Average Values of Elasticities, Growth Components and Thresholds**

Within a first step the coefficients of equation (2) have been estimated using OLS. The data have been decomposed into the regions of NRW, the CIC-district and the four sub-districts, and the sectors Industry, Trade and Transport and Services.

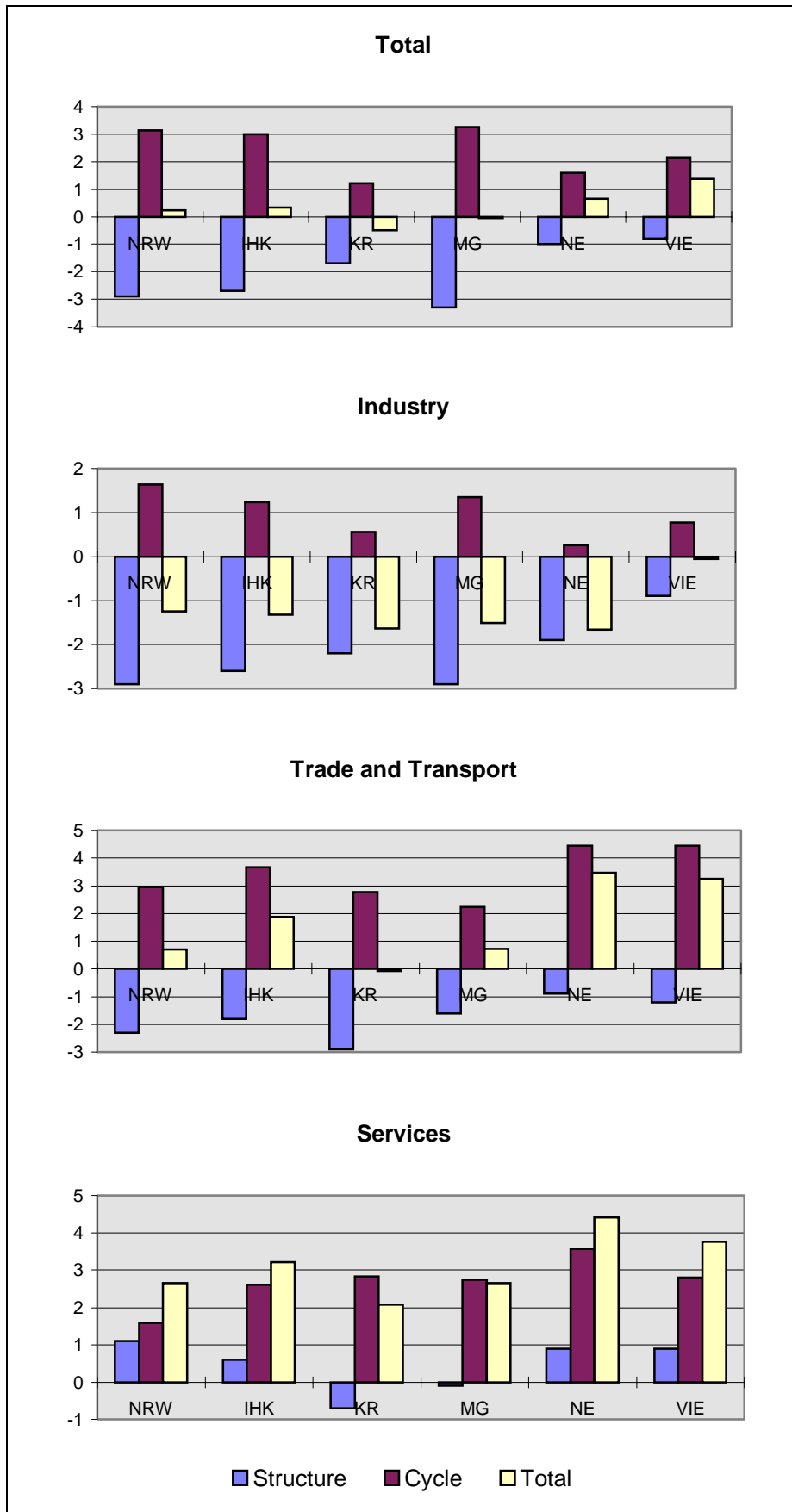
The estimation results are summarised in Table 1. Because of the growth rate-transformation of the employment and output data, the corresponding coefficients can be interpreted as elasticities. Therefore the cyclical sensitivity of employment ( $a_1$ ) seems to

**Table 1: The Impact of Output on Employment in NRW and in the CIC-District Middle Lower Rhine**  
Results of the Regression Analysis of Equation (2) - 1980 to 1995

Region	Sector			Industry			Trade and Transport			Services		
	a <sub>1</sub>	a <sub>2</sub>	R <sup>2</sup> C	a <sub>1</sub>	a <sub>2</sub>	R <sup>2</sup> C	a <sub>1</sub>	a <sub>2</sub>	R <sup>2</sup> C	a <sub>1</sub>	a <sub>2</sub>	R <sup>2</sup> C
NRW	0,72***	-2,9***	0,52	0,61***	-2,9***	0,55	0,63***	-2,3**	0,53	0,23	1,1	0,07
CIC-District	0,64***	-2,7***	0,43	0,42***	-2,6***	0,38	0,61***	-1,8*	0,60	0,36**	0,6	0,23
Krefeld	0,32*	-1,7**	0,14	0,22*	-2,2**	0,10	0,75***	-2,9***	0,60	0,44**	-0,7	0,30
Mönchengl.	0,73***	-3,3***	0,49	0,51***	-2,9***	0,40	0,45**	-1,6**	0,50	0,40**	-0,1	0,20
Neuss	0,31*	-1,0	0,11	0,08	-1,9***	0,00	0,58***	-0,9	0,60	0,46	0,9	0,06
Viersen	0,40***	-0,8	0,35	0,21*	-0,9	0,19	0,62***	-1,2	0,49	0,35**	0,9	0,29

Own Calculation: R<sup>2</sup>C: Coefficient of Determination, - \*\*\* significant on the level of 1 %, of \*\* 5 %, and \* 10 % respectively.

**Figure 3: Components of Employment Changes - 1980 - 1995**  
Annual Average Contributions to Growth in Percentage Points



be a little lower regarding the CIC-district (0,64) as with respect to the state of NRW in average (0,72). These differences do hold especially for the industrial sector, whereas regarding Trade and Transport the elasticities are very similar. Looking at the service sector the cyclical sensitivity of employment in the CIC-district are above the state averages (no significant elasticity estimations). Within the CIC-district the very high cyclical sensitivity of industrial employment in Moenchengladbach is worth mentioning. Considering the sectors Trade and Transport and Services, the impact of production changes on employment in the sub-district of Krefeld is the strongest.

The estimations of the coefficients  $a_2$  can be interpreted as (hypothetical) average change rates of employment, which could have been observed if there had not been any cyclical impact on employment (structure effect). According to these results in particular Moenchengladbach and Krefeld had to accept considerable problems of adjustments caused by structural change. This holds especially for the industrial sector in Moenchengladbach and for Trade and Transport in Krefeld (both structural decrease of -2,9 % on annual average). No significant (no positive nor negative) cycle-autonomous employment changes could be identified for the service sector in all regions. At least until the mid 90s a structural relief of the Northrhine-Westphalian labour market owing to a more or less sufficient growth of the service sector could not be found.

In a second step average cycle and structure components of employment changes have been calculated using equation (3). The results are shown in Figure (3). As can be taken from this figure, the structural component had „pulled down“ overall employment changes in the industrial sector and in Trade and Transport. Regarding the industrial sector the cyclical impacts only in case of Viersen were able to compensate these negative structural effects. With respect to the other regions the cyclical push was too small, so that total employment changes of the analysed period were negative on average.

It is true that a negative structural effect holds also for Trade and Transport without exception. But there the cyclical impulses were strong enough to compensate the structural effects (Krefeld) or even to overcompensate them (other). Small (but of course not significant) positive structure effects and additional (significant) positive cycle impulses in all regions (with the exception of Krefeld) have led to considerable

employment growth in the service sector. The highest growth rates can be found for Neuss and Viersen.

In the last third step of the average oriented analysis, equation (4) has been used to calculate the values of employment thresholds for regions and sectors in NRW and the CIC-District. The results are presented in Table 2. Especially the threshold values regarding Krefeld, but of course for Moenchengladbach too, indicate the fundamental structural problems of both regional labour markets. This holds also for the industrial sector and regarding the insufficient economic strength of the service sector in these regions. Therefore, the process of structural change can be characterised as a more or less unsuccessful shift from the industrial to the service economy.

**Table 2: Employment Thresholds - Annual Averages 1980 - 1995 in %**

	Total	Industry	Trade and Transport	Services
NRW	4,0	4,8	3,7	(-4,8)
CIC-District	4,2	6,2	3,0	(-1,7)
Krefeld	5,3	10,0	3,9	(1,6)
Mönchengladbach	4,5	5,7	3,6	(0,3)
Neuss	(3,2)	(23,8)	(1,6)	(-2,0)
Viersen	(2,0)	(4,3)	(1,9)	(-2,6)

Values in brackets are to be interpreted very carefully because at least one of the coefficients have been estimated as not significant.

#### 4.2. Results of Recursive Estimations

Components of employment changes as well as employment threshold values mentioned above apply to the average of the analysed period and can be interpreted as indicators for the structural change of output and employment. The multitude of analyses on the economics of structural change indicates that in the course of processes of change both, components and the resulting thresholds - may vary over time. For that reason recursive coefficient figures have been estimated using equation (5). As the basic regression period the years from 1980 until 1986 have been chosen. These values then have been used to

calculate time varying components of employment changes (equation (6)) and threshold values (equation (7)). The results of employment components are shown in the following figures, which only the results for total output and production without sectoral disaggregation are presented.

**Figure 4: Components of Total Employment Changes in NRW in Comparison**  
Percentage Changes 1987 - 1996

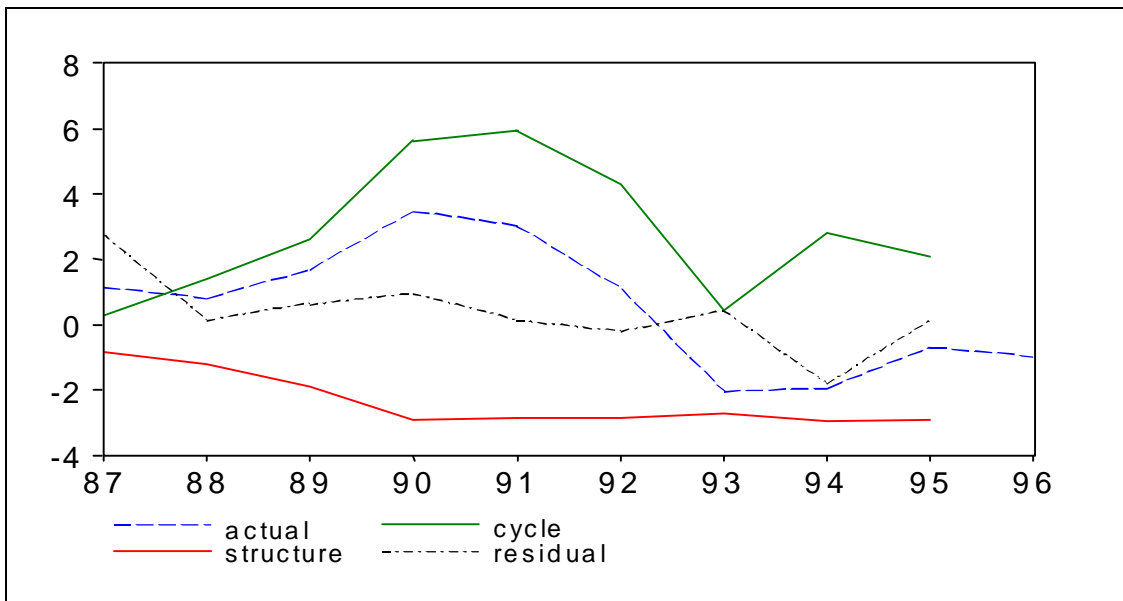
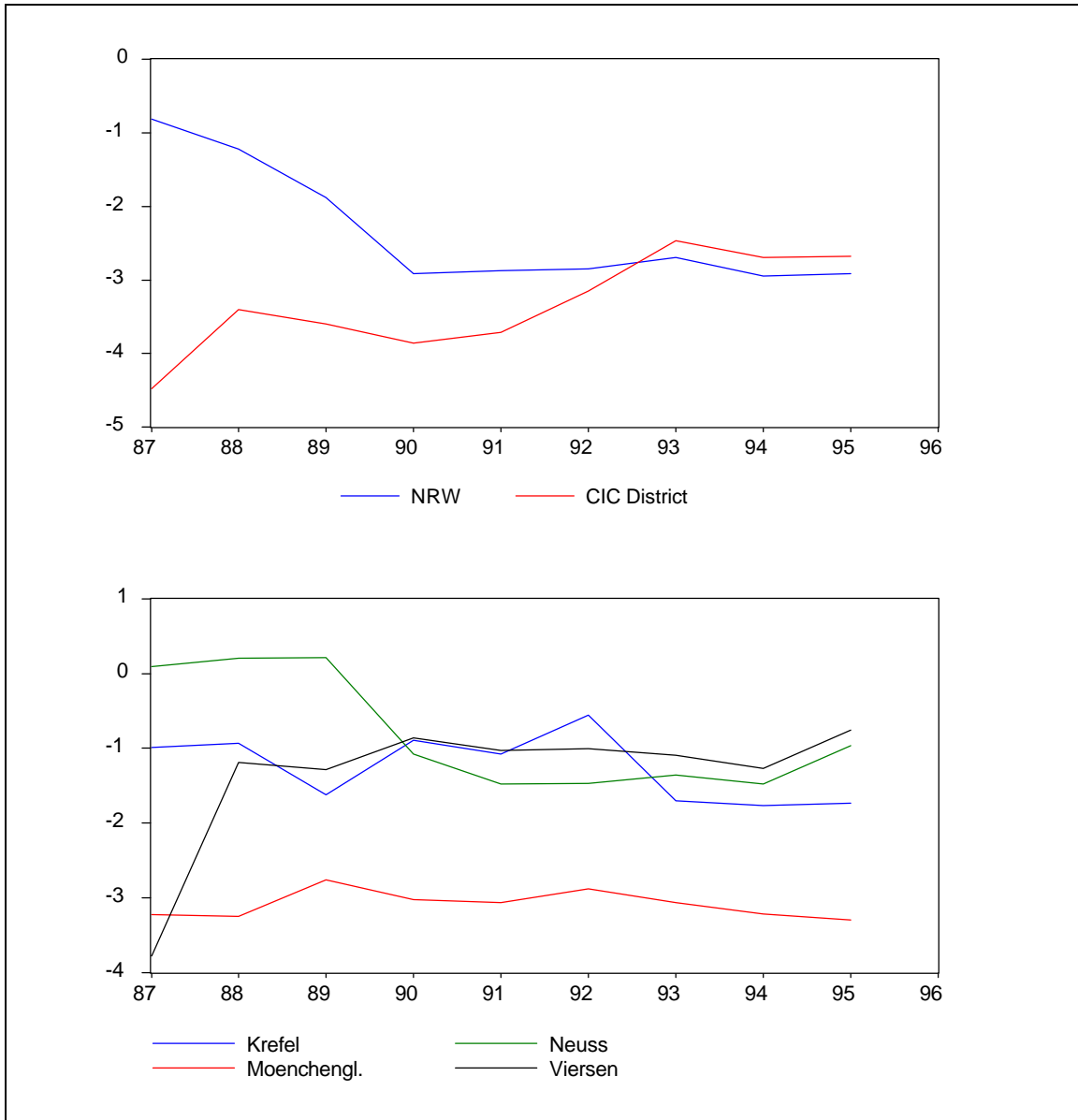


Figure 4 shows the decomposition of total employment growth in NRW. While the structural deterioration of the labour market situation is shown by the slowdown of the structure component from -1% (1987) to nearly -3% (1990), the cyclical impulses of unification boom 1990/91 and those of 1993 recession are well recognisable.

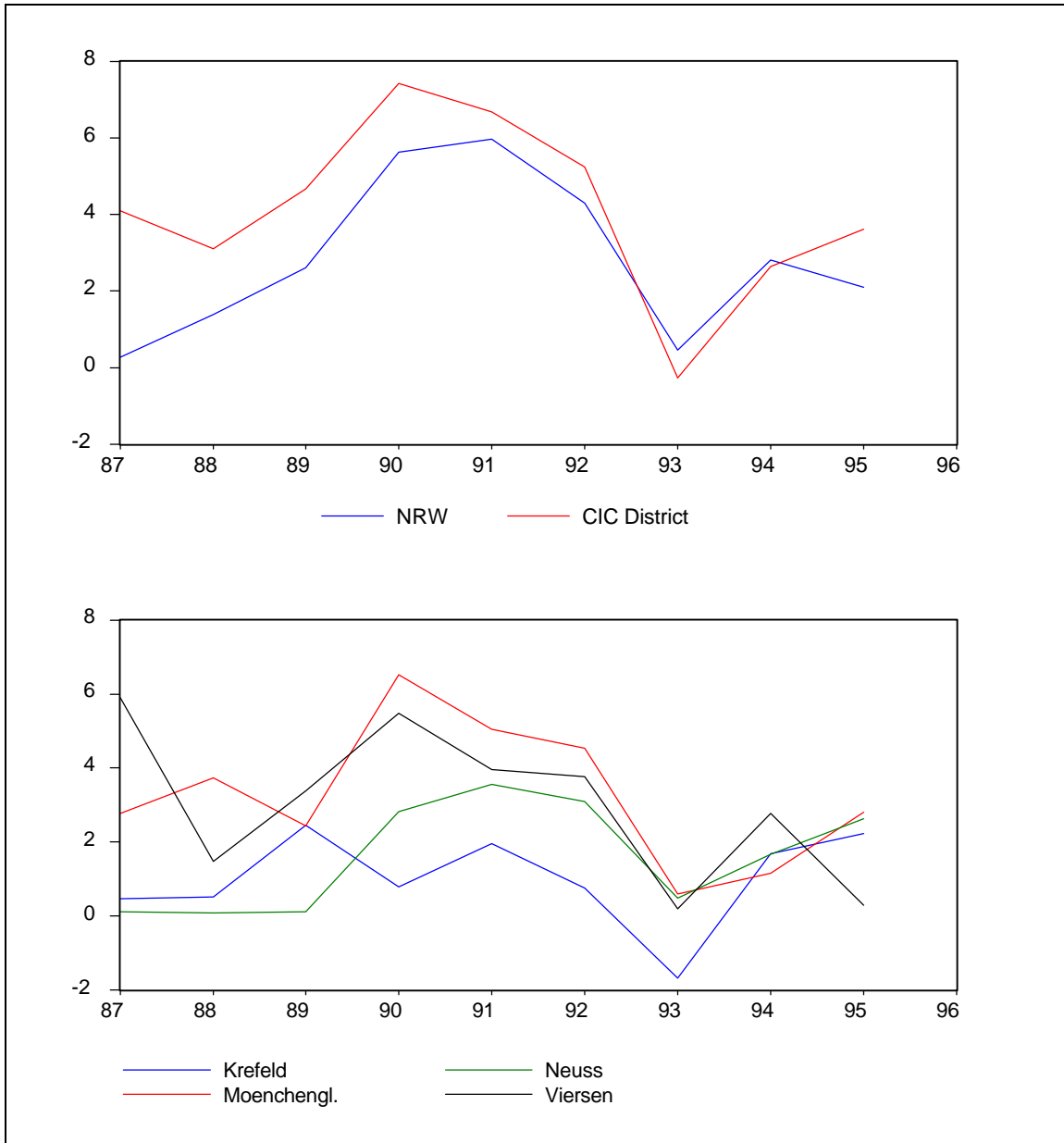
It could be interesting to compare structure and cyclical components between regions. The upper picture of Figure 5 shows the adjustment of the structural components of the NRW and CIC District average values. While there has been a worsening of the situation in NRW, for the CIC District a relative improvement can be seen. Looking at the sub-regions of the CIC District, the relative stable but considerable structure problems of Moenchengladbach, and to a some lower extend to Krefeld, can be seen. A significant improvement of the relative position of Viersen during 1987/88 and (+3 percent points) and a considerable deterioration of that of Neuss in 1989/90 (-1,5 percent points) are shown in the lower graph of Figure 5.

**Figure 5: Structural Components of Total Employment Changes**  
Percentage Changes 1987 - 1996



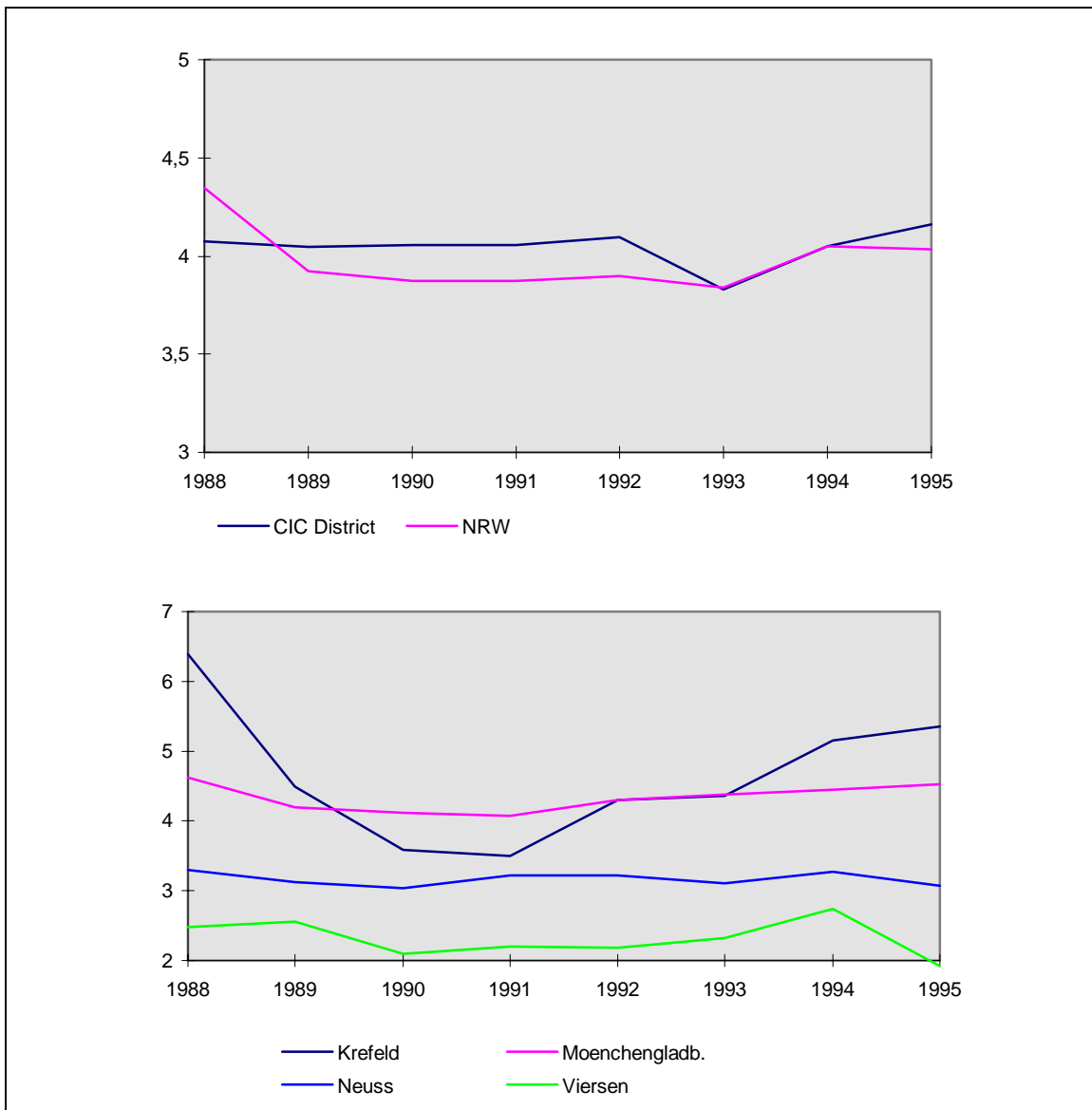


**Figure 6: Cyclical Components of Total Employment Changes**  
Percentage Changes 1987 - 1996



Regarding the cyclical components there has also been an adjustment of NRW and CIC District average values during the period of analysis. Between 1992 and 1994 there are no significant differences (upper graph of Figure 6). With respect to the sub-regions, Moenchengl. and Viersen registered the strongest impulses from German unification effects. While for Viersen a less stronger lagged impulse can be detected, only relatively small cyclical impulses can be seen for Krefeld, what is - owing to the latter - the case for the whole period of analysis.

**Figure 7: Employment Thresholds in %, 1988 -1995**



By calculation of time varying employment thresholds we get a summarise of the common development of structural and cyclical components of employment changes. The upper picture of Figure 7 indicates stable employment thresholds for North Rhine-Westphalia and the overall CIC-District with only slight variations. This holds for three of the four sub districts, too: The lower graph of Figure 7 shows Viersen with the lowest threshold, followed by Neuss and Moenchengladbach. Significant changes on employment thresholds can only be seen for Krefeld, which notes on average the highest threshold (Table 2). Threshold values decreased first from 6% (1988) to 3.5% (1991), then they increased once more up to over 5%.

The reason for that is that we calculated relatively low negative structure effects, which could be easily compensated by only small positive cycle impulses.

#### 5. Suggestions for Further Research

As a central result of our analyses we have got relatively stable employment threshold figures with one exception. This exception is the sub-district of Krefeld, which had considerable problems of structural change in the past and still has it nowadays. One reason might have been the significant drop of the threshold during the period of German unification, what perhaps signalled a structural progress, which in fact only has been temporary. Whereas one hypothesis about the relationship between business cycle and structural change says, the intensity of structural change is high during periods of upswing and low during phases of downswing, lessons from the economics of German unification tell us the opposite: The high backlog demand of Eastern Germany “conserved” some of the non-competitive structures (sectors, companies) to some extent, capacities had been increased instead to take them down. In the case of Krefeld, the relatively slight cyclical effects (Figure 6, lower graph) in connection with small (negative) structural impulses on employment (Figure 5, lower graph) signalled such an economic recovery and hindered structural changes.

Using the “Verdoorn-interpretation” of the structural effects of production on employment as changes of labour-productivity (we must take the opposite sign of the components), especially the enterprises in the regions of Moenchengladbach and Krefeld reached productivity improvements of 3 % (Moenchengladbach) and 1,5 % (Krefeld) per year, more than the enterprises in Viersen and Neuss. This is the other side of the coin and the result of measures to increase efficiency of production in the so called “older industries”.

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<sup>1</sup> Sometimes this elasticity is also called “marginal intensity of employment”. See Commission of the European Communities, Employment in Europe 1989. Luxembourg 1989, p. 49.

<sup>2</sup> Compare e.g. Klauder, W., Zur Entwicklung von Produktivität und Beschäftigungsschwelle. Mitteilungen aus der Arbeitsmarkt- und Berufsforschung. 1/1990, pp. 86ff. and Pusse, L., Überlegungen zur formalen und empirischen Bestimmung der Beschäftigungsschwelle. Mitteilungen aus der Arbeitsmarkt- und Berufsforschung. 1/1990, pp. 100ff.

<sup>3</sup> For details see Ledolter, J., Adaptive Estimation and Structural Change in Regression and Time Series Models. In: P.Hackl (Ed.), Statistical Analysis and Forecasting of Economic Structural Change. Berlin a.o. 1989, S. 191ff.