

## Gross and Net Employment Flows in Manufacturing Industries\*

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This article uses the unique data set of employment in about 7000 manufacturing establishments in the German Federal State of Lower Saxony in the period 1978 - 1989 to investigate the dynamics of employment. It contributes to the only sporadic research on the empirical microeconomics of labor demand.

### I. Introduction

In the article on labor demand *Hamermesh* 1986, 455, states: "It is true that, in contrast to the myriad studies of labor supply behavior based on households, there is a shocking absence of research on the empirical microeconomics of labor demand." Explanations of the mobility of workers between different states of the employment system, sectors, regions, and occupations were linked to choices of workers and the traits of workers affecting their decisions. With the current availability of longitudinal employment data of individual firms several recent empirical investigations have focused on the fluctuations of labor demand and have started to measure and explain their implications for the mobility and turnover of labor.

In this article, firstly, some of these studies are briefly summarized. Secondly, the data base which consists of annual employment data between 1978 and 1989 of about 7000 manufacturing establishments in the German Federal State of Lower Saxony is described. Thirdly, the empirical results are presented in three steps: Annual net employment changes are decomposed into employment variations due to plant creation, expansion, contraction, and closing. The dynamics of employment are examined for technologically advanced industries and the remaining part of manufacturing. Finally, the impact of firm size on variations of employment demand is analyzed by testing Gibrat's law of proportionate growth. Section V contains the conclusions.

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## II. Previous Studies

Several studies of the manufacturing sector in the US have shown that net employment changes or the annual growth rate of net employment computed from cross-section data comprise only a small part of gross employment flows (*Dunne/Roberts/Samuelson* 1989 a, 1989 b; *Leonard* 1988; *Davis/Haltiwanger* 1990). According to *Dunne/Roberts/Samuelson* 1989 a) a substantial amount of new jobs is created by expanding and newly founded firms in shrinking sectors and regions whereas jobs are reduced in growing sectors and regions by plant closures and shrinking firms, too. *Leonard* 1988 computed for the American manufacturing industry that on average 9.1 % of all jobs disappeared in the period 1978 to 1982, i. e. an average duration of a job of 11.1 years.

German investigations of the dynamics of employment based on data of firms use four sources of information:

- official employment statistics of the Federal Employment Institute (*Cramer/Koller* 1988; *Boeri/Cramer* 1991);
- official statistics of manufacturing (*Dahremöller* 1986);
- data from credit rating institutions for firms (*Eckart/v. Einem/Stahl* 1986);
- samples of firms (*Fritsch* 1990).

On the basis of the employment statistics *Boeri/Cramer* 1991 compute for the decade 1977 to 1987 an average gross flow of employment as the sum of the absolute values of employment changes in growing and shrinking firms as well as in newly founded and closing firms of 16 percent and an average net employment change of 0.5 percent. Annual job turnover rates exceed net employment changes by a large amount and approximately 16.7 percent of employment is relocated every year. In accordance with American studies *Boeri* and *Cramer* demonstrate that the variance of job growth rates of plants cannot be explained by sectoral differences. Job gains and losses occur basically within sectors of economic activity. Furthermore, it is shown that in the long run newly founded firms are the driving force of employment growth. In 1987, 17.6 percent of all employed persons worked in establishments which were founded in the decade under investigation.

*Dahremöller* 1986 analyzes employment growth in manufacturing in North Rhine-Westphalia from 1978 to 1984 with establishment data from official statistics of manufacturing. The employment reduction of 270 000 persons is composed of a negative balance between newly founded firms and plant closures in a magnitude of 90 000 employees and a reduction of employment of 180 000 persons in firms existing in 1978 and 1984. Employ-

ment gains in establishments in existence during the entire period occurred only in small firms with 1 to 9 employed persons.

The study of *Eckardt/v. Einem/Stahl* 1986 compares the development of employment in the Ruhr district and the region of Frankfurt. The data source is a sample of firms drawn from the archives of a credit rating institution containing longitudinal employment information for firms. The dynamics of employment is again decomposed into newly founded plants, closed plants and expanding and shrinking firms. The regional comparison shows that the Ruhr district lost a higher percentage of jobs due to closing and contracting firms than the region of Frankfurt. With respect to employment gains, however, the Ruhr district was favored by newly founded firms vis à vis the region of Frankfurt. Employment growth in existing firms was noticeably stronger in Frankfurt than in the other region.

The investigation of *Fritsch* 1990 is based on a sample of about 3300 manufacturing firms in selected regions of Germany. The firms responded to a postal questionnaire in the summer and fall 1986. This study suffers from a survivor bias since the data set contains retrospective informations merely for those firms existing in 1986. Fritsch shows that firm size and age as well as the sectoral and regional affiliation of establishments contribute insignificantly to employment dynamics. According to the findings of Fritsch, the development of demand for goods has as substantial impact on the employment growth of firms. This apparently trivial relationship will attract more interest if one takes into account that the variable growth of demand is not primarily an external variable which firms cannot modify, but is subject to strategies of firms. *Fritsch* 1990, 325, explicitly mentions diversifications of supplied goods, quality improvements, market penetration efforts, and the qualification of employees, specifically the proportion of employees involved in research and development.

In the light of the results of previous research we conclude that virtually all studies find an enormous discrepancy between gross employment flows and net employment change. We have to conclude, too, that our understanding of employment dynamics and labor demand is not very developed.

### III. Data

The empirical investigation uses official annual employment data between 1978 and 1989 of about 7000 establishments which constitute the manufacturing sector of the German Federal State of Lower Saxony. All establishments with at least 20 employees working in either the local production unit or in the company owning the unit are covered by the official survey. The size of an establishment is measured by the average number of working persons. This average is computed from the employment data

reported in the monthly surveys. Employment growth is defined as the percentage change of employment between two periods.

Three limitations of the data base have to be pointed out. First, only firms at or above the threshold size of 20 employed persons are included in the sample. An establishment failing to attain this threshold in one period is excluded from the survey in this year. Conversely, a growing firm might exceed the minimum size and, thus, be covered by the survey from this year on. 'Entries' and 'exits' of firms, therefore, have to be interpreted from the perspective of this line of demarcation. Second, relocations of establishments from (or to) Lower Saxony to (or from) another region or country are recorded as plant closings (plant births). In the same vein, establishments changing their centre of activities from manufacturing industries to the sector of services or vice versa are inadequately depicted as exits or entries.

#### IV. Empirical Results

##### 1. Components of Net Employment Changes in Capital and Consumer Goods Industries

For each biannual period between 1978 and 1989 the absolute change in employment was computed and divided by the size of employment in the respective first year in order to obtain the annual growth rates, i. e. the rates of net employment change. These rates are decomposed into four components:

- rates of employment increase in growing firms (plant expansions),
- rates of employment decrease in shrinking firms (plant contractions),
- rates of employment increase in new firms (plant births),
- rates of employment decrease in closing firms (plant closings).

A summation of these four components yields the rate of net employment change, while a summation of the absolute values and a division by the rate of net change results in an indicator of turbulence which can be considered a measure of heterogeneity of the development of firms. It should be noted, however, that a *very* small rate of net change in employment (i. e., a net change of some persons only) leads to *extremely* high values of this index of turbulence (see, e. g., the results reported for small firms in Table 2 for the period 1978 - 1979). This should be kept in mind when the level of heterogeneity is compared across size classes, industries, or periods.

Tables 1 and 2 show the findings for the capital and consumer goods industries. In each period gross employment flows drastically exceed the rate of net change of employment, and employment losses in contracting plants coexist with employment gains in expanding plants. Interestingly,

the sum of the absolute values of gross changes was more or less constant in the periods covered, and, therefore, the heterogeneity of the development of firms as measured by the indicator of turbulence was more pronounced in periods of small changes of net employment (absolute values). A simple regression of the natural logarithm of the absolute values of the turbulence indicator on the logarithmic values of the rate of net change yields the following equations:

$$\begin{aligned} \text{Capital goods: In turbulence indicator} &= 2,11 - 0,988 \ln \text{ rate of net change} \\ &\quad (52,3) \quad (-23,84) \\ \text{with } R^2 &= 0,98 \text{ and t-values in parentheses.} \end{aligned}$$

$$\begin{aligned} \text{Consumer goods: In turbulence indicator} &= 2,37 - 0,995 \ln \text{ rate of net change} \\ &\quad (66,6) \quad (-47,11) \\ \text{with } R^2 &= 0,99 \text{ and t-values in parentheses.} \end{aligned}$$

The regression coefficient of the log of rate of net change is about minus one. This suggests that gross changes are more or less independent from net changes – a relationship that requires additional future investigations.

To summarize, the first result is:

Gross flows of employment substantially exceed net employment changes. The relationship between the turbulence indicator, which measures heterogeneity of employment development between firms, and the rate of net employment change is strongly negative.

## 2. Dynamics of Employment in Technologically Advanced Industries

Employment in the manufacturing industries of our sample decreased from 725 695 in 1978 to 672 338 employees in 1989, i.e. by 7.35 percent. In the same period establishments assigned to the technology sector<sup>1</sup> increased employment by approximately 10 000 persons, whereas plants in the remaining part of the manufacturing sector had to sustain employment losses in the magnitude of 62 000 employees. Consequently, the percentage of employees working in the technology sector grew from 39,9% (1978) to 44,5 (1989). As Table 3 demonstrates the rate of net employment change was positive in 5 of 11 periods in the technology sector. Additionally, gross employment flows in this sector exceed net employment changes by a substantial amount. Regressing again the values of the turbulence indicator on the rate of net employment change the following two equations are obtained:

<sup>1</sup> In defining the technology sector we follow the so-called “NIW-Liste” published by the Lower Saxonian Institute of Economic Research (Niedersächsisches Institut für Wirtschaftsforschung – NIW). For details, see *Grupp/Legler* 1986; by and large, the technology sector is composed of industries which have a R & D/sales ratio of 3 percent or more.

*Technology Sector:*

ln turbulence indicator = 2,01 – 0,954 ln rate of net change  
(39,14) (–21,43)

with  $R^2 = 0,98$  and t-values in parentheses

*Rest of Manufacturing Industries:*

ln turbulence indicator = 2,36 – 0,99 ln rate of net change  
(59,3) (–32,5)

with  $R^2 = 0,99$  and t-values in parentheses

As in the case of capital and consumer goods industries we find a strong negative relationship between the two variables in both sectors of manufacturing. The heterogeneity of the development of firms, apparently, is very similar in these two sectors.

Therefore, our second conclusion is:

In the period of investigation (1978 - 1989) establishments of the technology sector experience a more favorable growth of employment than their counterparts in the rest of manufacturing industries. The findings suggest, however, that a pattern between gross and net employment flows prevails in the technology sector which is very similar to the rest of manufacturing industries.

### 3. Firm Size and the Dynamics of Employment

The role of small and newly founded firms in the process of job creation has been widely investigated in recent years (*Brown/Hamilton/Medoff* 1990; *Sengenberger/Loverman/Piore* 1990; *Boeri/Cramer* 1991). The subsequent hypotheses presumably explain the specific employment increase in small firms (*Storey/Johnson* 1987). The importance of internal economics of scale and the optimal firm size has declined. Small firms adapt easily to a more differentiated demand and demonstrate greater flexibility than bigger firms concerning changing market conditions. Small firms benefit from strategies of bigger firms trying to reduce net output. The number of newly founded firms is positively correlated with the level of unemployment.

As in the case of all firms in the capital and consumer goods industries we find that the rate of net employment change of small firms (< 50 employees) is the result of opposing and substantially larger gross changes (Tables 1, 2). It is evident, too, that new and closing establishments have a stronger impact on employment variations in small compared to big firms. As was pointed out this is partly due to statistical conventions and data limitations like the minimum size of firms included in the sample.

In an additional step the hypothesis is tested that employment growth is independent of firm size, i.e. small and large establishments face the same probability of growth in each period. In that case the variable under

scrutiny (growth rate of employment) can be modelled in accordance with Gibrat's Law of Proportionate Growth. A test of the validity of Gibrat's Law can be based on the following equation (*Chesher* 1979) using ordinary least squares:

$$z_{t,i} = g_1 \cdot z_{t-1,i} + g_2 \cdot z_{t-2,i} + u_{t,i},$$

$t$  = time index

$i$  = index for firms

$z_{t,i}$  = deviation of the logarithm of the size of establishment at time  $t$  from the mean of the logarithms of the sizes of establishments at time  $t$ . Analogous definitions are used for  $z_{t-1,i}$  and  $z_{t-2,i}$ , respectively,

$u$  = disturbance term

$g_1, g_2$  = parameters to be estimated.

Chesher shows that  $g_1 = b + r$  and  $g_2 = -b \cdot r$ , with  $r$  as coefficient of autocorrelation and  $b$  as coefficient expressing the growth rate of employment. Gibrat's law, consequently, implies  $b = 1$  and  $r = 0$  or  $g_1 = 1$  and  $g_2 = 0$ . With the estimated values for  $g_1$  and  $g_2$ ,  $b$  and  $r$  can be computed from

$$(b, r) = 0,5 [g_1 \pm (g_1^2 - 4g_2)^{0,5}].$$

The empirical investigation was performed for firms in the sector of capital and consumer goods, respectively. Three size classes of firms were distinguished: small firms (< 50 employees), medium firms (50 < employees ≤ 250), and large firms (> 250 employees). The results, which are not reported in tabular form (compare *Wagner* 1992), demonstrate that the coefficient  $b$  is persistently close to one. In the capital goods industry, the extreme values of  $b$  are computed as 1.0172 and 0.9813 for small firms, 0.9882 and 0.6948 for medium firms, and 1.0075 and 0.9692 for large firms. Consequently, growth rates of employment do not differ between small and large firms. Surprisingly, most values of the coefficient of autocorrelation  $r$  are positive. For small firms in the capital goods sector, for example, the following extreme values of  $r$  are computed: 0.4727 and 0.0933. This must be interpreted as 'persistence of growth', i. e. growth rates of a given firm from one period to the next period are not independent, as is suggested by Gibrat's law. Since our model does not include variables which could explain the persistence of growth, it is captured by positively autocorrelated errors.

As a summary of our principal results in this section we formulate:

Gross employment flows exceed net employment changes in the case of small firms as well as in the two other firm size categories. No evidence is found that establishments exhibit different employment growth rates according to firm size classes. However, there is substantial evidence of a persistence of growth rates for several periods which is independent of firm size.

## V. Conclusions

In accordance with other investigations this study finds that gross employment flows are large and exceed net employment changes. A closer look at labor demand is, therefore, indispensable for an analysis of labor turnover. Perhaps not surprisingly establishments of the technology sector grew faster than their counterparts in the remaining section of manufacturing, although a similar pattern of gross and net employment changes prevails. Small firms do not grow systematically faster or slower than large firms, however, a persistence of growth is detected for all size classes of establishments. Like *Brown/Hamilton/Medoff* 1990, 91, we conclude: "Sentiment aside, the results of our research suggest a clear message for policies affecting large and small firms: Do not judge employers by their size alone."

Large gaps of knowledge remain, however, as the determinants of employment growth of firms are unknown. The official statistics, generally, do not contain the information to reduce this gap. Therefore, panel data on firms are strongly needed as a basis for future research.

## Summary

This article uses the unique data set of employment in about 7000 manufacturing establishments in Lower Saxony in the period 1978 - 1989 to investigate the dynamics of employment. Basic findings include: (1) Gross flows of employment substantially exceed net employment changes. (2) Establishments in technologically advanced sectors experience a more favourable growth of employment; the pattern between gross and net employment flows, however, is persistent. (3) No evidence is found that establishments exhibit different employment growth rates according to firm size classes; employment growth rates persist for several periods independent of firm size, however.

## Zusammenfassung

In diesem Aufsatz wird die Beschäftigungsdynamik mit einem bislang der Forschung nicht zugänglichen Datensatz für ca. 7000 Industriebetriebe aus Niedersachsen im Zeitraum 1978 bis 1989 untersucht. Zu wesentlichen empirischen Ergebnissen zählen:

(1) Bruttobeschäftigungsströme sind deutlich größer als die Nettobeschäftigungsveränderungen. (2) Die Beschäftigung wächst in Betrieben technologieorientierter Sektoren schneller als in den übrigen Wirtschaftssektoren. Ein Zusammenhang zwischen Bruttobeschäftigungsströmen und Nettobeschäftigungsveränderungen läßt sich jedoch auch hier nachweisen. (3) Unterschiedliche Wachstumsraten der Beschäftigung nach Betriebsgrößenklassen lassen sich nicht nachweisen. Unabhängig von Betriebsgrößenklassen zeigt sich jedoch eine Persistenz des Wachstums der Beschäftigung von Betrieben über mehrere Perioden.



## Appendix

Table 1

## Employment change in firms from manufacture of capital goods in Lower Saxony (1978 - 1989)

| Period<br>$t_0$ $t_1$ | Firm size    | Net change in employment |                    | Components of net change as proportions of beginning-period employment |                  |                    |                | Index of turbulence |
|-----------------------|--------------|--------------------------|--------------------|--|------------------|--------------------|----------------|---------------------|
|                       |              | Number of persons        | Rate of change (%) | Plant births   | Plant expansions | Plant contractions | Plant closings |                     |
| 1978-1979             | All firms    | + 1696                   | + 0.47             | + 0.86   | + 3.86           | - 2.96             | - 1.29         | + 18.93             |
|                       | Small firms  | + 136                    | + 0.48             | + 7.39   | + 4.45           | - 3.40             | - 7.96         | + 48.01             |
|                       | Medium firms | + 380                    | + 0.69             | + 1.13   | + 4.45           | - 3.12             | - 1.78         | + 15.28             |
|                       | Large firms  | + 1180                   | + 0.43             | + 0.14   | + 3.69           | - 2.88             | - 0.51         | + 16.75             |
| 1979-1980             | All firms    | + 4057                   | + 1.13             | + 0.60   | + 4.06           | - 2.32             | - 1.22         | + 7.26              |
|                       | Small firms  | + 271                    | + 0.99             | + 5.11   | + 4.39           | - 3.61             | - 4.90         | + 18.16             |
|                       | Medium firms | + 264                    | + 0.48             | + 1.39   | + 4.53           | - 2.73             | - 2.71         | + 23.88             |
|                       | Large firms  | + 3522                   | + 1.27             | + 0.00   | + 3.94           | - 2.11             | - 0.55         | + 5.17              |
| 1980-1981             | All firms    | - 4216                   | - 1.16             | + 1.07   | + 1.70           | - 3.15             | - 0.78         | - 5.77              |
|                       | Small firms  | + 909                    | + 3.35             | + 10.39  | + 3.16           | - 5.21             | - 4.99         | + 7.09              |
|                       | Medium firms | - 392                    | - 0.70             | + 1.09   | + 3.36           | - 4.03             | - 1.12         | - 13.80             |
|                       | Large firms  | - 4733                   | - 1.69             | + 0.16   | + 1.22           | - 2.77             | - 0.30         | - 2.63              |
| 1981-1982             | All firms    | - 8765                   | - 2.44             | + 0.57   | + 2.00           | - 4.15             | - 0.87         | - 3.10              |
|                       | Small firms  | - 1916                   | - 6.68             | + 3.16   | + 2.31           | - 5.82             | - 6.33         | - 2.64              |
|                       | Medium firms | - 1169                   | - 2.12             | + 2.07   | + 3.04           | - 5.54             | - 1.69         | - 5.83              |
|                       | Large firms  | - 5680                   | - 2.07             | + 0.00   | + 1.75           | - 3.69             | - 0.13         | - 2.70              |
| 1982-1983             | All firms    | - 14358                  | - 4.10             | + 0.68   | + 1.04           | - 4.96             | - 0.86         | - 1.84              |
|                       | Small firms  | - 1676                   | - 6.21             | + 4.89   | + 2.45           | - 5.93             | - 7.62         | - 3.37              |
|                       | Medium firms | - 1547                   | - 2.82             | + 1.92   | + 2.56           | - 6.02             | - 1.28         | - 4.18              |
|                       | Large firms  | - 11135                  | - 4.15             | + 0.00   | + 0.59           | - 4.64             | - 0.10         | - 1.29              |
| 1983-1984             | All firms    | - 9683                   | - 2.88             | + 0.73   | + 1.92           | - 4.57             | - 0.97         | - 2.84              |
|                       | Small firms  | - 585                    | - 2.27             | + 6.05   | + 3.24           | - 3.88             | - 7.68         | - 9.19              |
|                       | Medium firms | - 952                    | - 1.74             | + 1.16   | + 3.62           | - 4.98             | - 1.53         | - 6.49              |
|                       | Large firms  | - 8146                   | - 3.19             | + 0.10   | + 1.42           | - 4.55             | - 0.17         | - 1.96              |
| 1984-1985             | All firms    | + 6267                   | + 1.92             | + 1.25   | + 4.34           | - 2.16             | - 1.51         | + 4.82              |
|                       | Small firms  | + 238                    | + 0.97             | + 7.07   | + 4.72           | - 3.52             | - 7.31         | + 23.38             |
|                       | Medium firms | - 287                    | - 0.53             | + 1.58   | + 5.42           | - 3.35             | - 4.17         | - 27.56             |
|                       | Large firms  | + 6316                   | + 2.56             | + 0.60   | + 4.07           | - 1.76             | - 0.35         | + 2.65              |
| 1985-1986             | All firms    | + 16139                  | + 4.86             | + 1.66   | + 5.74           | - 1.60             | - 0.95         | + 2.05              |
|                       | Small firms  | + 87                     | + 0.36             | + 6.79   | + 4.37           | - 3.52             | - 7.28         | + 61.34             |
|                       | Medium firms | + 2215                   | + 4.15             | + 1.91   | + 6.23           | - 2.66             | - 1.34         | + 2.93              |
|                       | Large firms  | + 13837                  | + 5.43             | + 1.12   | + 5.77           | - 1.19             | - 0.26         | + 1.53              |
| 1986-1987             | All firms    | - 870                    | - 0.25             | + 1.00   | + 3.09           | - 2.56             | - 1.78         | - 33.76             |
|                       | Small firms  | - 558                    | - 2.41             | + 6.62   | + 4.03           | - 3.43             | - 9.63         | - 9.85              |
|                       | Medium firms | + 1520                   | + 2.69             | + 2.28   | + 4.98           | - 3.28             | - 1.29         | + 4.39              |
|                       | Large firms  | - 1832                   | - 0.68             | + 0.25   | + 2.61           | - 2.33             | - 1.21         | - 9.39              |
| 1987-1988             | All firms    | - 4908                   | - 1.41             | + 0.60   | + 2.63           | - 3.46             | - 1.19         | - 5.59              |
|                       | Small firms  | - 179                    | - 0.79             | + 5.77   | + 4.28           | - 3.07             | - 7.81         | - 26.50             |
|                       | Medium firms | + 485                    | + 0.84             | + 1.38   | + 5.44           | - 3.31             | - 2.67         | + 15.19             |
|                       | Large firms  | - 5214                   | - 1.95             | + 0.00   | + 1.89           | - 3.53             | - 0.31         | - 2.94              |
| 1988-1989             | All firms    | + 9049                   | + 2.64             | + 1.84   | + 4.04           | - 2.32             | - 0.93         | + 3.46              |
|                       | Small firms  | + 2067                   | + 9.71             | + 14.19  | + 5.24           | - 3.63             | - 6.09         | + 3.00              |
|                       | Medium firms | + 4224                   | + 7.09             | + 5.51   | + 6.62           | - 2.94             | - 2.10         | + 2.42              |
|                       | Large firms  | + 2758                   | + 1.05             | + 0.00   | + 3.36           | - 2.07             | - 0.24         | + 5.38              |

Table 2

**Employment change in firms from manufacture of consumer goods in Lower Saxony  
(1978 - 1989)**

| Period<br>$t_0$ $t_1$ | Firm size    | Net change in employment |                    | Components of net change as proportions of beginning-period employment |                  |                    |                | Index of turbulence |
|-----------------------|--------------|--------------------------|--------------------|--|------------------|--------------------|----------------|---------------------|
|                       |              | Number of persons        | Rate of change (%) | Plant births   | Plant expansions | Plant contractions | Plant closings |                     |
| 1978-1979             | All firms    | + 332                    | + 0.24             | + 2.07   | + 3.77           | - 3.52             | - 2.07         | + 47.05             |
|                       | Small firms  | + 1                      | + 0.005            | + 9.00   | + 4.01           | - 3.82             | - 9.19         | + 4823.00           |
|                       | Medium firms | + 991                    | + 1.84             | + 2.15   | + 4.90           | - 3.11             | - 2.10         | + 6.66              |
|                       | Large firms  | - 660                    | - 1.03             | + 0.00   | + 2.75           | - 3.77             | - 0.00         | - 6.36              |
| 1979-1980             |              | - 551                    | - 0.40             | + 1.24   | + 3.28           | - 3.93             | - 0.99         | - 23.50             |
|                       |              | + 55                     | + 0.31             | + 5.91   | + 4.12           | - 4.34             | - 5.37         | + 64.53             |
|                       |              | + 7                      | + 0.01             | + 1.14   | + 4.10           | - 4.52             | - 0.70         | + 839.29            |
| 1980-1981             |              | - 613                    | - 0.97             | + 0.00   | + 2.31           | - 3.29             | - 0.00         | - 5.75              |
|                       |              | - 4670                   | - 3.42             | + 1.36   | + 2.10           | - 4.77             | - 2.11         | - 3.02              |
|                       |              | - 530                    | - 2.86             | + 8.32   | + 2.53           | - 6.13             | - 7.57         | - 8.51              |
| 1981-1982             |              | - 2348                   | - 4.19             | + 0.55   | + 2.46           | - 5.17             | - 2.03         | - 2.44              |
|                       |              | - 1792                   | - 2.89             | + 0.00   | + 1.65           | - 4.01             | - 0.54         | - 2.14              |
|                       |              | - 9582                   | - 7.27             | + 1.14   | + 1.23           | - 6.50             | - 3.14         | - 1.65              |
|                       |              | - 1477                   | - 7.97             | + 5.36   | + 2.12           | - 6.80             | - 8.65         | - 2.88              |
| 1982-1983             |              | - 3916                   | - 7.33             | + 0.95   | + 1.76           | - 7.41             | - 2.63         | - 1.74              |
|                       |              | - 4189                   | - 6.99             | + 0.00   | + 0.48           | - 5.59             | - 1.89         | - 1.14              |
|                       |              | - 6643                   | - 5.43             | + 1.13   | + 1.98           | - 5.41             | - 3.14         | - 2.15              |
|                       |              | - 1385                   | - 7.44             | + 5.95   | + 2.72           | - 5.48             | - 10.64        | - 3.33              |
| 1983-1984             |              | - 2573                   | - 5.31             | + 0.56   | + 2.71           | - 5.68             | - 2.91         | - 2.23              |
|                       |              | - 2685                   | - 4.86             | + 0.00   | + 1.09           | - 5.14             | - 0.81         | - 1.45              |
|                       |              | - 266                    | - 0.23             | + 2.20   | + 3.51           | - 2.96             | - 2.98         | - 50.62             |
|                       |              | - 300                    | - 1.74             | + 8.14   | + 3.42           | - 4.30             | - 9.00         | - 14.29             |
| 1984-1985             |              | + 429                    | + 0.93             | + 2.47   | + 4.50           | - 3.35             | - 2.69         | + 14.00             |
|                       |              | - 395                    | - 0.76             | + 0.00   | + 2.66           | - 2.17             | - 1.24         | - 8.03              |
|                       |              | + 76                     | + 0.06             | + 1.02   | + 4.10           | - 2.93             | - 2.13         | + 154.47            |
|                       |              | - 655                    | - 3.95             | + 6.62   | + 3.48           | - 4.91             | - 9.13         | - 6.11              |
| 1985-1986             |              | - 155                    | - 0.34             | + 0.18   | + 4.56           | - 3.62             | - 1.47         | - 28.59             |
|                       |              | + 886                    | + 1.65             | + 0.00   | + 3.90           | - 1.74             | - 0.51         | + 3.73              |
|                       |              | + 66                     | + 0.06             | + 2.35   | + 3.82           | - 3.12             | - 2.99         | + 214.73            |
|                       |              | - 370                    | - 2.33             | + 9.73   | + 3.32           | - 4.94             | - 10.78        | - 12.21             |
| 1986-1987             |              | + 184                    | + 0.41             | + 1.53   | + 4.70           | - 3.03             | - 2.78         | + 29.45             |
|                       |              | + 252                    | + 0.46             | + 0.88   | + 3.24           | - 2.75             | - 0.90         | + 16.82             |
|                       |              | - 890                    | - 0.77             | + 1.17   | + 3.49           | - 2.97             | - 2.46         | - 13.10             |
|                       |              | - 775                    | - 4.98             | + 6.39   | + 2.93           | - 3.90             | - 10.46        | - 4.76              |
| 1987-1988             |              | + 2                      | + 0.004            | + 0.83   | + 4.30           | - 3.24             | - 1.88         | + 2364.00           |
|                       |              | - 137                    | - 0.25             | + 0.00   | + 2.95           | - 2.49             | - 0.72         | - 24.33             |
|                       |              | + 501                    | + 0.44             | + 1.37   | + 3.72           | - 2.97             | - 1.68         | + 22.27             |
|                       |              | - 77                     | - 0.52             | + 7.40   | + 3.42           | - 3.79             | - 7.55         | - 42.35             |
| 1988-1989             |              | + 404                    | + 0.89             | + 1.05   | + 4.80           | - 3.16             | - 1.80         | + 12.18             |
|                       |              | + 174                    | + 0.32             | + 0.00   | + 2.90           | - 2.58             | - 0.00         | + 17.11             |
|                       |              | + 3678                   | + 3.20             | + 2.08   | + 4.54           | - 2.13             | - 1.30         | + 3.14              |
|                       |              | + 618                    | + 4.46             | + 11.03  | + 3.99           | - 3.42             | - 7.14         | + 5.73              |
|                       | + 1954       | + 4.25                   | + 1.90             | + 5.75   | - 2.29           | - 1.10             | + 2.60         |                     |
|                       | + 1106       | + 1.99                   | + 0.00             | + 3.66   | - 1.66           | - 0.00             | + 2.67         |                     |

Table 3: Employment change in the technology sector and in the rest of the industries in Lower Saxony (1978 - 1989)

| Period<br>$t_0$ $t_1$ | Sector            | Net change in employment |                    | Components of net change as proportions of beginning-period employment |                  |                    |                | Index of turbulence |
|-----------------------|-------------------|--------------------------|--------------------|--|------------------|--------------------|----------------|---------------------|
|                       |                   | Number of persons        | Rate of change (%) | Plant births   | Plant expansions | Plant contractions | Plant closings |                     |
| 1978 - 1979           | Technology sector | + 2 440                  | + 0.84             | + 0.85   | + 3.58           | - 2.81             | - 0.78         | + 9.52              |
|                       | Rest of industry  | + 1 265                  | + 0.29             | + 1.61   | + 3.94           | - 3.18             | - 2.09         | + 37.33             |
| 1979 - 1980           | Technology sector | + 5 047                  | + 1.73             | + 0.59   | + 4.25           | - 2.12             | - 1.00         | + 4.62              |
|                       | Rest of industry  | - 776                    | - 0.18             | + 0.98   | + 3.10           | - 3.04             | - 1.22         | - 47.36             |
| 1980 - 1981           | Technology sector | - 3 040                  | - 1.02             | + 0.67   | + 1.52           | - 2.62             | - 0.59         | - 5.30              |
|                       | Rest of industry  | - 7 367                  | - 1.68             | + 1.90   | + 2.03           | - 4.24             | - 1.36         | - 5.68              |
| 1981 - 1982           | Technology sector | - 6 172                  | - 2.09             | + 0.44   | + 1.84           | - 3.96             | - 0.44         | - 3.20              |
|                       | Rest of industry  | - 22 227                 | - 5.15             | + 0.75   | + 1.77           | - 5.74             | - 1.93         | - 1.98              |
| 1982 - 1983           | Technology sector | - 10 753                 | - 3.74             | + 0.82   | + 0.89           | - 4.84             | - 0.61         | - 1.91              |
|                       | Rest of industry  | - 19 678                 | - 4.81             | + 1.19   | + 1.77           | - 5.57             | - 2.19         | - 2.23              |
| 1983 - 1984           | Technology sector | - 6 956                  | - 2.51             | + 0.81   | + 1.85           | - 4.44             | - 0.73         | - 3.11              |
|                       | Rest of industry  | - 5 906                  | - 1.52             | + 1.80   | + 2.74           | - 4.03             | - 2.03         | - 6.97              |
| 1984 - 1985           | Technology sector | - 8 331                  | + 3.09             | + 1.46   | + 4.69           | - 1.73             | - 1.33         | + 2.98              |
|                       | Rest of industry  | - 6 039                  | - 1.58             | + 1.04   | + 3.26           | - 3.28             | - 2.60         | - 6.46              |
| 1985 - 1986           | Technology sector | + 16 847                 | + 6.07             | + 1.69   | + 6.14           | - 1.24             | - 0.52         | + 1.58              |
|                       | Rest of industry  | - 216                    | - 0.06             | + 1.89   | + 3.38           | - 3.19             | - 2.14         | - 184.58            |
| 1986 - 1987           | Technology sector | - 267                    | - 0.09             | + 0.85   | + 2.95           | - 2.15             | - 1.75         | - 84.99             |
|                       | Rest of industry  | - 4 248                  | - 1.13             | + 1.44   | + 5.18           | - 5.84             | - 1.19         | - 12.70             |
| 1987 - 1988           | Technology sector | - 2 421                  | - 0.82             | + 0.60   | + 2.41           | - 3.29             | - 0.54         | - 8.32              |
|                       | Rest of industry  | - 4 417                  | - 1.19             | + 1.09   | + 3.44           | - 4.08             | - 1.64         | - 8.61              |
| 1988 - 1989           | Technology sector | + 7 207                  | + 2.47             | + 1.68   | + 3.73           | - 2.32             | - 0.62         | + 3.38              |
|                       | Rest of industry  | + 7 239                  | + 1.98             | + 2.17   | + 4.30           | - 2.64             | - 1.85         | + 5.54              |

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