# Earnings and employment situation of East German men, 1990-93: an empirical investigation using panel data

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**Sonderforschungsbereich 186**
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# Statuspassagen und Risikolagen im Lebensverlauf

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by

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Preface

Projects in section C of the Special Collaborative Centre 186 ("Status Passages and Risks in the Life Course") deal with changes in the labour market status of individuals and pay particular attention to the last years of their employment history. Within this field, research project C5 places particular emphasis on chances for a gradual transition from work into retirement via part-time work and partial pensions.

This paper was completed when Sikandar Siddiqui was a visiting researcher at the project C5. It deals with the development of the earnings and employment situation of East German men in the sequel of the German unification. The economic transition led to massive job losses, while the wages of those still employed were gradually raised to a level which is meanwhile close to the one prevailing in the West. Since many older workers were bought off the labour market via public pre-retirement allowances, this paper clearly bears some relevance for research project C5. Moreover, it can be seen as a minor contribution to research project A4, which deals with occupational careers of young East German citizens.

From a methodological perspective, an econometric approach to the treatment of non-random sampling in panel data models is first described and then applied to the dataset in use, which is a subsample from the first four waves of the Socio-Economic Panel for East Germany. It consists of estimating wage and employment equations simultaneously on a cross-sectional basis and combining the resulting estimates by means of a two-stage minimum distance method.

Prof. Dr. Ansgar Weymann
Chair

## 1. Introduction

Following the economic and social union and the subsequent unification with West Germany, in the former German Democratic Republic (GDR) went through the most rapid and profound process of transformation among previously centrally planned economies in Eastern Europe. It is obvious that the vast majority of the East German citizens had enthusiastically welcomed a speedy unification, hoping that their standard of living would quickly catch up with the one prevailing in the West. In virtually all economic sectors, a stepwise adjustment of the East German wage level to the one of the West was agreed upon. The fact, however, that the productivity of labour could not keep in step with the rising wages is one of the major causes of the deep crisis that developed and still persists on the East German labour market. Privatisation of formerly state-owned companies resulted in massive job losses, the return to economic growth came slower than expected, and the demand for labour did not respond but very slowly to the beginning recovery. The average labour income in East Germany, which amounted to only 35% of the corresponding value in the West in June 1990, rose to more than 70% in the following three years, but it was only the persons still employed who benefited from this huge increase in its entirety.

In this paper, we present an empirical analysis of the factors determining the probability of employment and the level of labour incomes among East German males. We confine our analyses to men because the high degree of variation in the number of working hours among women clearly calls for a different type of model than the one described here. One of the main goals of our study is to examine the manner in which the so-called "human capital" variables, like schooling, vocational qualifications, and (potential) labour experience, influence the individual income and labour market status. Apart from that, we also aim at identifying some industry-specific wage differentials, attempt to evaluate the impact of involuntary short time work on a person's labour income, and try to quantify the influence of a person's age and health situation on the probability of being employed.

Another point of interest in this paper is more on the methodical side. We describe how the selectivity problem inherent in the estimation of earnings equations can be solved by AMEMIYA's (1985) Type 2-Tobit model, and demonstrate how this approach can be combined with a two-stage minimum distance method to yield consistent and asymptotically efficient estimates of the model's unknown parameters with panel data. The paper is organized as follows: In chapter 2, we describe the econometric approach our empirical investigation is based upon. Chapter 3 contains a summary description of the data used for estimation, and the empirical results are collected and commented upon in chapter 4. A short summary (chapter 5) concludes the article.

## 2. The Econometric Approach

*2.1. A Tobit model with separate selection equation for cross-sectional data*

In the following, we present an econometric model in which the statistical relationship between the individual market wage and employment status on one hand and various explanatory variables on the other is being modelled by one descriptive equation each. One of the main problems associated with such a study is the fact that a positive labour income can only be observed for individuals that are actually employed. If the parameters of the wage equation are estimated independently of the employment equation using the subsample of the persons employed, this is bound to result in inconsistent parameter estimates whenever the error terms in the two equations are correlated (see, e.g., DAVIDSON and MACKINNON, 1993, p. 542-545). In econometric literature, this is called self selection or incidental truncation and occurs, when sample data are drawn from a subset of a larger population of interest, which might be the case for models of labour supply or studies of income.
HECKMAN (1979, p. 153) discusses the bias that results from using a nonrandomly selected sample as a specification bias arising from a missing data problem, where the missing variable can be estimated by a two-step-procedure. The solution to this problem which is advocated here consists in estimating the wage and the employment equation simultaneously by the method of maximum likelihood, and to account for a possible correlation of their stochastic components, as suggested by AMEMIYA (1985, p. 385-387). Compared to HECKMAN'S two-step method, this approach results in more efficient estimates because it uses the information contained in the income data of the persons employed for the estimation of individual employment probabilities.

Assume that a cross-sectional dataset, containing information on a total of $N$ individuals at a given time $t$, is available. In the following, $y_{it}^*$ denotes person $i$'s market wage and $y_{it}$ his/her labour income at time $t$. The binary variable $d_{it}$ is used to indicate whether individual $i$ is employed $(d_{it}=1)$ or not $(d_{it}=0)$, and $d_{it}^*$ is the corresponding latent variable. The following equations are specified for $y_{it}^*$, $d_{it}^*$, and $d_{it}$:

$$\ln y_{it}^* = x_{it}'\beta_t + u_{it} \quad (1)$$

$$d_{it}^* = z_{it}'\delta_t + \varepsilon_{it}, \text{ and} \quad (2)$$

$$d_{it} = \begin{cases} 1, & if \quad d_{it}^* > 0 \\ 0, & if \quad d_{it}^* \leq 0 \end{cases} \quad (3)$$

The column vectors $x_{it}$ and $z_{it}$ have dimensions $K_1$ and $K_2$, respectively, and contain a variety of individual- and time-specific explanatory variables. $\beta_t$ and $\delta_t$ are unknown parameter vectors that have to be estimated from the sample. They carry the index $t$ because at least some of their elements are not necessarily assumed to be time-invariant. The scalar quantities $u_{it}$ and $\varepsilon_{it}$ are individual-specific realizations of the random variables $u_t$ and $\varepsilon_t$ which, in turn, are assumed to follow a bivariate normal distribution:

$$[u_t \quad \varepsilon_t]' \qquad N(0, \Sigma_t) \tag{4}$$

Due to the binary nature of the indicator $d_{it}$ the variance of $\varepsilon_t$ cannot be identified separately. We therefore introduce the following normalisation:

$$\Sigma_t = A_t A_t' \qquad \text{with} \quad A_t = \begin{bmatrix} a_{11,t} & 0 \\ a_{21,t} & 1 \end{bmatrix} \tag{5}$$

It is assumed that the individuals employed are being paid in accordance with their market wage. For persons not working, a wage rate cannot be observed, and the labour income in the corresponding period is zero per definition. This can be expressed as follows

$$y_{it} = \begin{cases} y_{it}^* & if \quad d_{it} = 1, \\ 0 & if \quad d_{it} = 0. \end{cases} \tag{6}$$

The joint density of the random variables $y_t$ and $d_t$ can thus be written as

$$f(y_t, d_t) = [\Pr(d_t = 0)]^{1-d_t} \cdot [f(y_t | d_t = 1) \cdot \Pr(d_t = 1)]^{d_t} \tag{7}$$

It follows from (4), that for given $z_t$, we obtain the following expression for the (unknown) probability of the event $(d_t = 0)$:

$$\begin{aligned} \Pr(d_t = 0) &= \Pr(z_t'\delta_t + \varepsilon_t \; < 0) \\ &= \Pr(\varepsilon_t < -z_t'\delta) \\ &= 1 - \Phi\left(\frac{z_t'\delta}{\sqrt{1 + a_{21}^{\;2}}}\right) \end{aligned} \tag{8}$$

Here and in the following, $\Phi(\cdot)$ denotes the cumulative distribution function and $\phi(\cdot)$ the probability density function of the standard normal distribution. By virtue of BAYES' decomposition formula (see, e.g., PUDNEY 1989, pp. 327-328), the product of the truncated density $f(\ln y_t \mid d_t = 1$ and the probability of the event $(d_t = 1)$, both conditional on $x_t$ and $z_t$, can be expressed as

$$f\left(\ln y_t \mid d_t = 1;\ x_t, z_t\right) \quad = \quad \Pr\left(d_t = 1 \mid \ln y_t, x_t, z_t\right) \cdot f\left(\ln y_t \mid x_t\right) \qquad (9)$$
$$= \Phi\left(z_t{}'\delta_t,\ -\frac{a_{21,t}}{a_{11,t}}\left(\ln y_t - x_t{}'\beta_t\right)\right) \cdot \frac{1}{a_{11,t}} \cdot \phi\left(\frac{\ln y_t - x_t{}'\beta_t}{a_{11,t}}\right)$$

This directly leads to the conclusion that the model's unknown parameters, $\beta_t, \delta_t$ $a_{11,t}$, and $a_{21,t}$ can be estimated consistently by the method of maximum likelihood. In their particular case, this amounts to maximising the objective function

$$\Lambda_t\left(\tilde{\beta}_t, \tilde{\delta}_t, \tilde{a}_{11,t}, \tilde{a}_{21,t}\right) \ := \ \sum_{i=1}^{N}\left(1 - d_{it}\right)\ln\left[1 - \Phi\left(\frac{z_{it}{}'\tilde{\delta}_t}{1 + \tilde{a}_{21,t}{}^2}\right)\right] \qquad (10)$$
$$+ \ d_{it} \cdot \ln\left[\Phi\left[z_{it}{}'\tilde{\delta}_t,\ -\frac{\tilde{a}_{21,t}}{\tilde{a}_{11,t}}\left(\ln y_{it} - x_{it}{}'\tilde{\beta}_t\right)\right] \cdot \frac{1}{\tilde{a}_{11,t}} \cdot \phi\left(\frac{\ln y_{it} - x_{it}{}'\tilde{\beta}_t}{\tilde{a}_{11,t}}\right)\right]$$

with respect to all of its arguments.

*2.2. Estimation for Panel Data*

Up to this point, it was assumed that the dataset available for estimation consists of a single cross section collected at a given time *t*. We now turn to the case where a total number of $T$ cross sections ("panel waves"), collected in consecutive periods and referring to the same set of $N$ observational units (here: individuals), are at the researcher's disposal. Among the main advantages of datasets of this kind, which are usually referred to as balanced panels, is the fact that they enable the econometrician to test whether certain statistical relationships between economic variables can be regarded as stable over time, and to separate individual- and time-specific random components of the variable(s) under investigation. In the case of a *T*-wave panel, the system of equations set up by (1) to (3) and (6) extends to a system of *4T* equations. For notational convenience, we collect the unknown parameters referring to a cross-section *t* in the vector

$$\theta_t \ := \ \left[\beta_t', \delta_t', a_{11,t}, a_{21,t}\right]. \qquad (11)$$

The $T$ parameter vectors $\theta_1$ to $\theta_T$ , in turn, are stacked to obtain the vector

$$\theta \ := \ \left[\theta_1', \theta_2', \ldots, \theta_T'\right] \qquad (12)$$

As it is common in econometric models for panel data, it will be assumed that either all or at least most of the elements of the vectors $\theta_1$ to $\theta_T$ are invariant over time. In a very general form, a restriction of this kind can be expressed as

$$g(\theta,\alpha) \;:=\; \theta - h(\alpha) \;=\; 0 \;. \tag{13}$$

where $\alpha$ is a parameter vector of dimension $p \;<\; \dim(\theta)$ which has to be estimated at last.

The econometric model described here can be understood as a non-linear multivariate model with equality constraints across the particular equations. For the sake of simplicity, we assume all error terms to be stochastically independent of the regressors of all waves. In this case, we can utilize a two-stage method to obtain a consistent and asymptotically efficient estimator of $\alpha$. The first step of the corresponding estimation procedure consists of computing a consistent unconstrained estimate $\hat{\theta}^{(u)}$ of $\theta$ by maximizing the criterion function (10) for each of the $T$ panel waves separately. As it was calculated under disregard of possible correlations between the error terms referring to different waves (and thus on the basis of a mis-specified likelihood function), $\hat{\theta}^{(u)}$ can be termed a pseudo-maximum-likelihood estimate. It follows from the general theory of extremum estimators (see, e.g. GOURIÉROUX and MONFORT, 1989, vol. I, pp. 223-228), that the asymptotic covariance matrix of $\hat{\theta}^{(u)}$ is

$$\Omega \;:=\; J^{-1} \cdot K \cdot J^{-1}$$

with

$$J \;:=\; \begin{bmatrix} J_1 & \cdot & \cdot & 0 \\ \cdot & J_2 & & \cdot \\ \cdot & & \ddots & \cdot \\ 0 & & & J_T \end{bmatrix}, \quad J_t \;:=\; E\left[\frac{\partial^2 \ln \Lambda_{it}(\tilde{\theta}_t)}{\partial\tilde{\theta}_t\,\partial\tilde{\theta}_t'}\Big|\tilde{\theta}_t = \theta_t\right],$$

$$K \;:=\; \begin{bmatrix} K_{11} & K_{12} & \cdot & K_{1T} \\ K_{21} & K_{22} & & \cdot \\ \cdot & & \ddots & \cdot \\ K_{T1} & & & K_{TT} \end{bmatrix},$$

$$\text{and} \quad K_{ts} \;:=\; E\left[\frac{\partial \ln \Lambda_{it}(\tilde{\theta}_t)}{\partial\tilde{\theta}_t}\frac{\partial \ln \Lambda_{it}(\tilde{\theta}_s)}{\partial\tilde{\theta}_s'}\Big|\tilde{\theta}_t = \theta, \tilde{\theta}_s = \theta_s\right] \;. \tag{14}$$

Being a function of the unknown parameter vector $\theta$, the matrix $\Omega$ itself is also unknown to the researcher. However, a consistent estimate $\hat{\Omega}$ of $\Omega$ can be calculated by replacing the expectations operator $E[\cdot]$ in (14) by its sample analogue (the arithmetic mean) and the vector $\theta$ by its unconstrained estimate $\hat{\theta}^{(u)}$, which yields

$$\hat{\Omega} \;:=\; \hat{J}^{-1}\cdot\hat{K}\cdot\hat{J}^{-1}$$

with

$$\hat{J} \;:=\; \begin{bmatrix} \hat{J}_1 & \cdot & \cdot & 0 \\ \cdot & \hat{J}_2 & & \cdot \\ \cdot & & \ddots & \cdot \\ 0 & & & \hat{J}_T \end{bmatrix}, \quad \hat{J}_t \;:=\; \frac{1}{N}\sum_{i=1}^{N}\left[\frac{\partial^2 \ln \Lambda_{it}(\tilde{\theta}_t)}{\partial\tilde{\theta}_t\,\partial\tilde{\theta}_t'}\bigg|_{\tilde{\theta}_t=\theta_t}\right],$$

$$\hat{K} \;:=\; \begin{bmatrix} \hat{K}_{11} & \hat{K}_{12} & \cdot & \hat{K}_{1T} \\ \hat{K}_{21} & \hat{K}_{22} & & \cdot \\ \cdot & & \ddots & \cdot \\ \hat{K}_{T1} & & & \hat{K}_{TT} \end{bmatrix},$$

$$\text{and}\quad \hat{K}_{ts} \;:=\; \frac{1}{N}\sum_{i=1}^{N}\left[\frac{\partial \ln \Lambda_{it}(\tilde{\theta}_t)}{\partial\tilde{\theta}_t}\frac{\partial \ln \Lambda_{it}(\tilde{\theta}_s)}{\partial\tilde{\theta}_s'}\bigg|_{\tilde{\theta}_t=\theta,\,\tilde{\theta}_s=\theta_s}\right]. \tag{15}$$

Since the unconstrained estimate $\hat{\theta}^{(u)}$ converges to the true parameter vector $\theta$ as $N$ approaches infinity, the unknown parameter vector $\alpha$ can be estimated consistently by minimizing the quadratic criterion function

$$\xi(\hat{\theta}^{(u)},\tilde{\alpha}) \;:=\; g(\hat{\theta}^{(u)},\tilde{\alpha})'\cdot\hat{\Omega}^{-1}\cdot g(\hat{\theta}^{(u)},\tilde{\alpha}) \tag{16}$$

with respect to $\tilde{\alpha}$ provided the restriction (13) holds. As pointed out by GOURIÉROUX and MONFORT (1989, vol. II, p. 167), the optimum value of $\xi(\cdot)$ follows asymptotically a $\chi^2$ distribution with [dim($\theta$) - dim($\alpha$)] degrees of freedom if the equality constraint $g(\theta,\alpha) = 0$ is valid. This is of particular importance in the context of the model studied here since it provides the basis for a simple test for the stability of some (or all) of the parameters over time.

## 3. Data and Sample Selection

Our study is based on the first four waves of the German Socio-Economic Panel (GSOEP) for East Germany. This longitudinal survey, which is based on annual interviews and of which

the first cross-section was collected immediately before the economic and social union came into effect, contains detailed information on the economic and social situation of about 4.500 individuals living in more than 2.100 households (see SCHUPP and WAGNER, 1991a, for a thorough description of the sampling technique).
The dataset used for our investigation is a balanced panel of 951 East German men born between 1924 and 1965. These relatively narrow all limits were chosen in order to exclude persons still studying or working as an apprentice from the sample, and because we chose to discard individuals who reached the minimum retirement age during the sampling period.

As the dependent variable of our earnings equation, we chose the logarithm of a person's monthly net labour income, evaluated at the East German Consumer Price Index for 1990. Using net rather than gross earnings as the endogenous variable in this context is mainly motivated by the assumption that individuals know their effectively disposable net labour income better than their gross earnings, and that, as a consequence, their statements about the former tend to be more precise. (In fact, some GSOEP respondents reported exactly the same amount as their gross and net earnings, which is most probably due to ignorance regarding gross labour income but might also reflect incidental gains from participation in the shadow economy).

To a large extent, our choice of regressors is governed by the theory of human capital formation and its relation to individual earnings, as pioneered by BECKER (1964) and MINCER (1974). However, the extent to which the explanatory variables in use can be reasonably compared to those for West Germany appears to be rather limited in some cases. This mainly applies to the information on schooling and educational and attainments. From the beginning of the 1960's, every pupil in the former German Democratic Republic was obliged to attend the so-called "Polytechnic Secondary School" until completing the tenth form. Successful completion of two more years of schooling led to the "Certificate of Advanced Secondary Education" ("Abitur"), which, in turn, was the qualification required for the admission to university. Before the unification, compulsory courses in such ideology-driven subjects as "Marxism/Leninism" played an important role in the curricula of schools and academic institutions in East Germany, and politically non-compliant students could be denied academic as well as advanced secondary education. As a result, individual investment in human capital was much less a result of personal preferences and abilities in the former GDR than it was in Western countries.

Another interesting point in this context is that the share of unskilled workers in the GDR'S labour force was considerably lower than in the West, and that, on the other hand, the percentage of academics was somewhat higher. As pointed out by SCHUPP and WAGNER (1991b), however, a large number of employees in the GDR were over-qualified compared to the demands of their actual jobs, so that it would be potentially misleading to associate a certain formal qualification with a corresponding occupation.

This fact and the above-mentioned peculiarities of the GDR's educational system give rise to the question in how far individuals with different educational attainments prior to the German unification managed to adjust successfully to the economic conditions prevailing in the newly-established market economy. We therefore include a variety of dummy variables related to schooling as well as different kinds of vocational and academic education in both the earnings and the employment equations. In order to assess the impact of on-the-job training on earnings, we also use the individuals' respective potiential labour experience, measured by its duration in years, as a regressor. This is done because using actual rather than potential experience would most probably have resulted in a problem of simultaneity bias since past individual-specific realizations of the employment dummy $d$ cannot reasonably be assumed to be stochastically independent of the random variable $u_t$ in the earnings equation. As pointed out by LICHT and STEINER (1991, p. 102) a problem implied by this procedure is that temporary breaks in an individual's employment history, as caused (for example) by a change of employer, are not captured by this variable. To a certain extent, however, this drawback can be made up for by including the dummy variable N_ORIG, which indicates whether or not a person is still working in the profession (s)he was originally trained for, in the set of regressors. The possible influence a person's health and marital status can exert on net earnings and the employment probability is taken into consideration through the inclusion of appropriate explanatory variables.

Apart from the human capital variables, we also use a number of regressors referring especially to some particularities of the East German labour market and general economic situation. As to the earnings equation, we concentrate on a total of ten dummy variables indicating the respective individual's affiliation with different economic sectors selected according to their size and relative economic importance. This is done in order to capture inter-industry wage differences caused by sector-specific wage settlements agreed upon by trade unions and employers' associations, and to keep track of alterations in the distribution of earnings that accompany the process of structural change following the unification. We also have to use an indicator for involuntary short-time work (INVSTW), which is available from the second panel wave onwards, because this was a widespread phenomenon in East Germany during the sampling period and resulted in (gross) income losses of up to 38% for the persons involved. Similarly, the dummies EWB and EWG ( = 1 if a person is employed in former West Berlin or West Germany, respectively) are of high importance because of the considerable East-West wage differences prevailing on the macro level. Definitions and descriptive statistics of the variables in use are gathered in tables 1 and 2.

| Table 1: Definitions of Variable in Use | |
|---|---|
| **Variable** | **Description** |
| | **I. Dependent variable of the earnings equation** |
| YLNET | Log of monthly real net labour income |
| | **II. Human capital-related variables** |
| CASE | Binary variable. CASE = 1 if a person holds the Certificate of Advanced Secondary Education ("Abitur"). |
| 8YS | Dummy variable indicating eight years of schooling. |
| MASTER | = 1 if a person holds the degree of a master craftsperson; MASTER = 0 otherwise. |
| TT_SCHOOL | Dummy variable indicating whether someone graduated from a trade or technical school. |
| UNI | indicates posession of a university degree. |
| | **III. Dummy variables for various economic sectors** |
| PUB_ADM | Public administration |
| MIN_EP | Mining and energy production |
| CHEM | Chemistry |
| IR_STEEL | Iron and steel industry |
| M_ENG | Mechanical engineering and car production |
| ELEC | Electrical engineering |
| TEXTILE | Textile goods industry |
| F_LX | Foodstuffs and luxuries |
| CONSTR | Construction sector |
| TRADE | Trade sector |
| | **IV. Further Socio-economic variables** |
| PEXP | Potential labour force experience; defined as age minus years of schooling minus six |
| MARRIED | = 1 if a person is married; MARRIED = 0 otherwise. |
| M_WS | = 1 if a person is married and living with his/her spouse. M_WS = 0 otherwise. |
| N_ORIG | Dummy variable indicating that someone is currently not working in the profession (s)he was originally trained for |
| INVSTW | Indicator for involuntary short-time work |
| EWG | = 1 if a person is employed in the Western part of Germany (excluding Berlin) |
| EWB | = 1 if a person is employed in former West Berlin |
| D_DISAB | Degree of disability |
| UNM | = 1 if a person is not married |
| AGLT30 | Dummy variable. AGLT30 = 1 if a person is younger than 30. |
| AG4549 | Dummy variable. AG4549 = 1 if $45 \leq age \leq 49$. |
| AG5054 | Dummy variable. AG5054 = 1 if $50 \leq age \leq 54$. |
| AGGE55 | Dummy variable. AGGE55 = 1 if $age \geq 55$. |

**Table 2: Descriptive Statistics**

| Variable | Mean | Std.Deviation | Minimum | Maximum |
|---|---|---|---|---|
| YLNET | 999.49 | 666.73 | 0.000 | 18 774 |
| CASE | 0.201 | 0.401 | 0.000 | 1.000 |
| 8YS | 0.295 | 0.456 | 0.000 | 1.000 |
| MASTER | 0.123 | 0.329 | 0.000 | 1.000 |
| TT_SCHOOL | 0.159 | 0.366 | 0.000 | 1.000 |
| UNI | 0.133 | 0.339 | 0.000 | 1.000 |
| PUB_ADM | 0.236 | 0.425 | 0.000 | 1.000 |
| MIN_EP | 0.032 | 0.176 | 0.000 | 1.000 |
| CHEM | 0.036 | 0.187 | 0.000 | 1.000 |
| IR_STEEL | 0.061 | 0.240 | 0.000 | 1.000 |
| M_ENG | 0.063 | 0.242 | 0.000 | 1.000 |
| ELEC | 0.044 | 0.206 | 0.000 | 1.000 |
| TEXTILE | 0.010 | 0.098 | 0.000 | 1.000 |
| F_LX | 0.016 | 0.126 | 0.000 | 1.000 |
| CONSTR | 0.124 | 0.329 | 0.000 | 1.000 |
| TRADE | 0.054 | 0.226 | 0.000 | 1.000 |
| PEXP | 27.215 | 11.325 | 7.000 | 51.000 |
| MARRIED | 0.865 | 0.342 | 0.000 | 1.000 |
| M_WS | 0.856 | 0.351 | 0.000 | 1.000 |
| N_ORIG | 0.330 | 0.470 | 0.000 | 1.000 |
| INVSTW | 0.085 | 0.279 | 0.000 | 1.000 |
| EWG | 0.072 | 0.258 | 0.000 | 1.000 |
| EWB | 0.036 | 0.186 | 0.000 | 1.000 |
| D_DISAB | 0.036 | 0.154 | 0.000 | 1.000 |
| UNM | 0.088 | 0.284 | 0.000 | 1.000 |
| AGLT30 | 0.120 | 0.325 | 0.000 | 1.000 |
| AG4549 | 0.142 | 0.349 | 0.000 | 1.000 |
| AG5054 | 0.156 | 0.363 | 0.000 | 1.000 |
| AGGE55 | 0.087 | 0.281 | 0.000 | 1.000 |

## 4. Estimation Results

Using the dataset described above, we began by estimating the model set up in section 2.1 for each of the four panel waves separately. The estimation results obtained after this first step are presented in table 3. We then proceeded by combining the cross-sectional estimates for waves 2 to 4 by means of the minimum distance method described in section 2.2. The ones obtained for wave 1 were not included in this estimation procedure because the first cross-section of the GSOEP for East Germany does not contain any information about involuntary short-time work and on whether a person is employed in the West, and because these factors turned out to be of high importance for individual earnings in the subsequent cross-sections.

We estimated a total of four different variants, which are henceforth referred to as Model I to Model IV, of the approach described above, while gradually reducing the restrictiveness of the assumed equality constraints (see equation 13) upon the parameters: Model I assumes all coefficients to be constant over time, whereas Model II allows the intercept terms of both the earnings and the employment equation to vary over time. In Model III, the assumption of a time-invariant covariance matrix $\Sigma$ referring to the error terms $\varepsilon_t$ and $u_t$ in equation (4) is relaxed, too. Finally, in Model IV we estimate distinct employment equations for each of the three panel waves involved. The $\chi^2$ – statistics, by which the validity of the restrictions imposed can be tested, indicate that in none of these four cases the parameter constraints in use can be accepted on the basis of conventional significance levels. This finding, which might be regarded as somewhat disenchanting at first sight, has an important and plausible interpretation: It mirrors the fact that, obviously, the speedy and far-reaching process of transformation the East German economy has been going through has not yet led to the formation of a wage structure that can be regarded as relatively stable over time. Our discussion will therefore focus on the cross-sectional estimates, and only the results of the minimum distance procedure obtained with Model IV (the least restrictive among the panel models) are displayed in the text to facilitate a comparison. (As to the results for models I to III, the interested reader is referred to the appendix).

**Table 3:**
**Cross-sectional Estimates of Earnings and Employment Equation**

| | Wave 1 (1990) | | Wave 2 (1991) | | Wave 3 (1992) | | Wave 4 (1993) | |
|---|---|---|---|---|---|---|---|---|
| | Coefficient | t-stat. | Coefficient | t-stat. | Coefficient | t-stat. | Coefficient | t-stat |
| | | | | Earnings Equation | | | | |
| Constant | 6.806 | 93.46 | 7.046 | 68.24 | 7.008 | 62.51 | 7.026 | 48.29 |
| PEXP | 0.105 | 1.84 | 0.002 | 0.02 | 0.075 | 0.90 | 0.106 | 1.00 |
| $PEXP^2$ | -0.016 | -1.50 | -0.001 | -0.10 | -0.019 | -1.31 | -0.028 | -1.52 |
| CASE | 0.015 | 0.32 | 0.020 | 0.33 | 0.072 | 1.16 | 0.114 | 1.58 |
| 8YS | -0.073 | -1.65 | -0.120 | -2.10 | -0.078 | -1.35 | -0.077 | -1.10 |
| MASTER | 0.081 | 2.15 | 0.089 | 1.81 | 0.045 | 0.91 | 0.002 | 0.03 |
| TT_SCHOOL | 0.153 | 4.11 | 0.158 | 3.29 | 0.130 | 2.69 | 0.136 | 2.32 |
| UNI | 0.204 | 3.68 | 0.211 | 2.96 | 0.164 | 2.30 | 0.206 | 2.46 |
| MARRIED | 0.029 | 0.79 | 0.067 | 1.39 | 0.111 | 2.28 | 0.108 | 1.95 |
| N_ORIG | -0.029 | -1.19 | -0.005 | -0.17 | -0.013 | -0.45 | -0.075 | -2.17 |
| PUB_ADM | 0.065 | 2.19 | -0.081 | -2.03 | -0.080 | -2.09 | 0.062 | 1.35 |
| MIN_EP | 0.089 | 1.30 | 0.125 | 1.50 | 0.096 | 0.99 | 0.170 | 2.23 |
| CHEM | 0.052 | 0.88 | -0.041 | -0.52 | -0.112 | -1.46 | -0.058 | -0.61 |
| IR_STEEL | 0.087 | 1.59 | 0.087 | 1.61 | -0.061 | -1.04 | -0.028 | -0.37 |
| M_ENG | 0.041 | 0.92 | 0.048 | 0.79 | 0.021 | 0.33 | 0.053 | 0.69 |
| ELEC | 0.001 | 0.01 | -0.085 | -1.15 | -0.111 | -1.39 | 0.024 | 0.23 |
| TEXTILE | -0.022 | -0.22 | -0.024 | -0.20 | -0.115 | -0.74 | 0.126 | 0.60 |
| F_LX | 0.038 | 0.50 | 0.054 | 0.45 | -0.085 | -0.79 | -0.007 | -0.05 |
| CONSTR | 0.078 | 1.94 | 0.131 | 2.78 | 0.147 | 3.31 | 0.091 | 1.74 |
| TRADE | 0.006 | 0.11 | -0.024 | -0.37 | -0.055 | -0.91 | -0.127 | -1.84 |
| D_DISAB | -0.367 | -3.77 | -0.322 | -2.47 | -0.266 | -2.03 | -0.405 | -2.75 |
| INVSTW | | | -0.259 | -6.95 | -0.237 | -3.44 | -0.216 | -2.18 |
| EWG | | | 0.033 | 0.35 | 0.356 | 5.73 | 0.281 | 3.67 |
| EWBWB | | | 0.168 | 2.48 | 0.202 | 1.34 | 0.171 | 1.17 |
| | | | | Employment Equation | | | | |
| Constant | 0.928 | 3.96 | 0.534 | 3.04 | 0.479 | 3.14 | 1.201 | 5.48 |
| AGLT30 | -0.102 | -0.70 | 0.303 | 1.54 | 0.297 | 1.59 | 0.004 | 0.02 |
| AG4549 | 0.265 | 1.42 | 0.138 | 0.88 | 0.091 | 0.72 | -0.008 | -0.06 |
| AG5054 | 0.190 | 0.91 | -0.117 | -0.92 | 0.232 | 1.51 | -0.127 | -0.96 |
| AGG55 | 0.160 | 0.57 | -0.041 | -0.24 | -0.601 | -4.63 | -0.958 | -7.24 |
| CASE | -0.277 | -1.45 | 0.146 | 0.66 | 0.226 | 1.27 | 0.041 | 0.24 |
| 8YS | -0.090 | -0.60 | -0.037 | -0.30 | -0.189 | -1.68 | -0.158 | -1.36 |
| MASTER | 0.280 | 0.85 | 0.014 | 0.09 | 0.171 | 1.19 | -0.067 | -0.52 |
| TT_SCHOOL | -0.147 | -0.77 | -0.033 | -0.23 | -0.036 | -0.28 | -0.031 | -0.24 |
| UNI | 0.477 | 1.82 | -0.094 | -0.40 | -0.257 | -1.33 | 0.036 | 0.18 |
| M_WS | 0.153 | 0.70 | 0.452 | 2.60 | 0.432 | 2.89 | -0.228 | -1.07 |
| UNM | 0.066 | 0.26 | 0.295 | 1.33 | 0.226 | 1.21 | -0.453 | -1.86 |
| D_DISAB | -0.684 | -2.29 | -0.750 | -2.95 | -0.528 | -2.07 | -0.552 | -2.14 |
| $a_{11}$ | 0.155 | 5.64 | 0.209 | 9.02 | 0.204 | 10.11 | 0.312 | 14.88 |
| $a_{21}$ | 0.577 | 42.86 | 0.641 | 40.88 | 0.637 | 40.45 | 0.647 | 32.19 |
| $\rho$ | 0.725 | | 0.500 | | 0.498 | | 0.504 | |
| $(1/N) \cdot \ln L$ | 0.7801 | | 0.7204 | | 0.9402 | | 0.9508 | |

A first interesting feature of our results is that the hump-shaped age-earnings profile which is typically found in corresponding studies for traditionally market-based economies, cannot be verified with adequate certainty in our estimates for the years after the unification. Obviously, the work experience gained in the socialist companies and public authorities of the former GDR lost most of its economic value after the introduction of the West German economic and social system in the East. Among the other human capital-related variables, only two appear to be of importance for individual earnings. Successful attendance of a trade or technical school, in which East German students used to go through four years of training with vocational as well as quasi-academic elements, has a statistically significant positive impact on individual earnings. The second group of individuals to whom this finding applies is the one of the academics. This might be a little surprising since, as already mentioned, academic curricula in the GDR used to contain extensive compulsory lessons in Marxism/Leninism, and loyalty to the prevailing political system was a necessary condition for admission to as well as graduation from university. It would be interesting to find out whether or not the income difference we observe is limited to (or at least more pronounced among) graduates of ideologically less "suspicious" subjects like, e.g., mathematics or engineering, but this is rendered impossible to us due to the lack of sufficiently detailed data. The supposition that, in spite of the questionable admission criteria described above, academics were (on average) more able to more capable of adjusting to the demands of the newly-introduced market economy, appears to be quite plausible at first sight. The fact that neither university graduates nor those from trade or technical schools appear to exhibit a higher employment probability than average during the years 1991 to 1993, however, casts doubt on this interpretation and shows that the apparently privileged position of these individuals is shared only by those who made a lucky draw in the employment lottery.

With regard to the sector-specific dummy variables, we do not find any significant effects with the notable exceptions of the construction sector on one hand and the public administration on the other. Workers in the construction sector benefited remarkably by the enormous boom in the building industry that set in shortly before the establishment of the economic and social union among the two Germanys and still prevails at present. As to the public administration's personnel, the cross-sectional parameter estimates reveal that this previously privileged group lost the prominent position it held in the former GDR, its earnings even dropping below average in the two years after the unification.

**Table 4:**
**Minimum Distance Panel Estimates for Waves 2 to 4; Model IV**

| | Earnings equation | | Employment equation | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Wave 2 | | Wave 3 | | Wave 4 | |
| | Coefficient | t-stat. | Coefficient | t-stat | Coefficient | t-stat | Coefficient | t-stat |
| Constant | 6.993 | 93.09 | 0.540 | 4.45 | 0.496 | 4.63 | 1.213 | 5.31 |
| YEAR92 | 0.052 | 4.39 | | | | | | |
| YEAR93 | 0.140 | 10.33 | | | | | | |
| PEXP | 0.048 | 0.96 | | | | | | |
| $PEXP^2$ | -0.012 | -1.38 | | | | | | |
| CASE | 0.032 | 0.71 | 0.173 | 0.72 | 0.214 | 1.19 | -0.126 | -0.79 |
| 8YS | -0.096 | -3.07 | -0.095 | -1.03 | -0.148 | -1.84 | -0.100 | -1.16 |
| MASTER | 0.059 | 1.99 | -0.063 | -0.62 | 0.171 | 1.42 | -0.027 | -0.26 |
| TT_SCHOOL | 0.149 | 5.39 | -0.096 | -0.95 | 0.039 | 0.41 | 0.014 | 0.11 |
| UNI | 0.198 | 3.86 | -0.043 | -0.19 | -0.209 | -1.19 | 0.174 | 1.07 |
| MARRIED | 0.091 | 2.85 | | | | | | |
| N_ORIG | -0.019 | -1.29 | | | | | | |
| PUB_ADM | -0.055 | -2.91 | | | | | | |
| MIN_EP | 0.087 | 2.59 | | | | | | |
| CHEM | -0.035 | -0.41 | | | | | | |
| IR_STEEL | 0.015 | 0.55 | | | | | | |
| M_ENG | -0.001 | -0.03 | | | | | | |
| ELEC | -0.037 | -0.84 | | | | | | |
| TEXTILE | 0.054 | 1.00 | | | | | | |
| F_LX | -0.044 | -1.13 | | | | | | |
| CONSTR | 0.099 | 3.87 | | | | | | |
| TRADE | -0.019 | -0.60 | | | | | | |
| INVSTW | -0.254 | -10.98 | | | | | | |
| EWG | 0.141 | 4.87 | | | | | | |
| EWB | 0.162 | 3.98 | | | | | | |
| D_DISAB | -0.177 | -1.47 | -0.645 | -2.77 | -0.498 | -2.18 | -0.557 | -2.52 |
| AGLT30 | | | 0.298 | 1.70 | 0.156 | 0.88 | 0.083 | 0.61 |
| AG4549 | | | 0.164 | 1.45 | 0.075 | 0.71 | -0.074 | -0.60 |
| AG5054 | | | -0.104 | -1.14 | 0.049 | 0.37 | -0.097 | -0.85 |
| AGG55 | | | -0.013 | -0.10 | -0.609 | -6.51 | -0.835 | -6.78 |
| M_WS | | | 0.475 | 4.01 | 0.399 | 3.80 | -0.254 | -1.11 |
| UNM | | | 0.257 | 1.52 | 0.221 | 1.72 | -0.481 | -1.99 |
| $a_{11}$ | | | 0.202 | 15.42 | 0.186 | 13.42 | 0.241 | 9.59 |
| $a_{21}$ | | | 0.634 | 50.65 | 0.623 | 53.96 | 0.612 | 50.55 |
| ρ | | | 0.496 | | 0.489 | | 0,482 | |
| $\chi^2(d.f.=46) = 106.1924$ | | | | | | | | |

Disabled people, who used to be the stepchildren of GDR's seemingly all-embracing social policy during the communist era, remain a severely disadvantaged problem group on the East German labour market. The coefficients referring to the degree of disability in the earnings and employment equations are negative and statistically significant, exceeding virtually all of the remaining coefficients in absolute value. This indicates that an improved integration of handicapped individuals into the labour market still is an urgent necessity in the field of social policy.

Apart from that, employment prospects have turned particularly dull for individuals age 55 and above since mid-1991.This is confirmed by the significantly negative coefficient the corresponding dummy variable bears in the last two cross-sections of our four-wave panel. To a certain extent, however, our results also reflect that since autumn 1991, more than half a million East Germans in this age group were "bought off" the labour market by means of a specific "pre-retirement allowance" ("Altersübergangsgeld"), of which critics say that it was mainly introduced to keep official unemployment figures on a seemingly tolerable level.

Involuntary short-time work, as it is captured by the dummy variable INVSTW, is another specific feature of current German labour market policies since 1991. In East Germany, individuals who have to suffer temporary cuts in working hours and corresponding losses in gross income as a consequence of corporate restructuring processes in the aftermath of the unification are granted a compensatory payment by the Federal Employment Office which usually limits the decline in net income to about 20% of its original level. This, too, is mirrored by our estimates for waves 2 to 4.

Finally, we find some (although not unequivocal) evidence for the supposition that East Germans who commute to the West earn higher wages than others. The results obtained on a cross-sectional basis indicate that commuting to West Germany was very rewarding in terms of labour income in 1992 and 1993, whereas a significant lead of West Berlin over East Germany could only be detected for the year 1991. The interpretation of these coefficients is complicated by the fact that East German regions lying close to the former West German border managed to catch up with the West faster - and to a higher degree - than others. Unfortunately, the lack of sufficiently differentiated regional indicators impedes an attempt to account for this important factor in a more detailed manner.

## 5. Summary and Conclusions

In the years following the German unification, the East German economy in its entirety was subject to a rapid and far-reaching process of structural change. While overall labour incomes rose considerably, the relatively egalitarian wage structure that used to be typical of the GDR was gradually replaced by the more efficiency-oriented one of the West. The process of economic transformation was accompanied by a huge decline in the demand for labour, which led to an unemployment crisis which is still far from being banned, and forced many elderly workers to exit the labour force a long time before reaching the minimum retirement age. In the process of wage equalization between East and West, the booming construction sector took the lead, leaving most of the other industries a good deal behind. The "inverted U"-shape of the age-earnings profile, which can be found in many empirical studies referring to market-based economies, cannot (yet) be verified for East Germany.

The economic recovery that accompanies the structural changes in the East German economy has been slow to affect the labour market. As many of the ex-communist countries in Eastern Europe have meanwhile become serious competitors to Germany as a whole in at least some economic sectors, solving this problem might take longer and require more severe adjustment processes than previously expected. The times of economic change, it seems, are far from being over.

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## Appendix:

# Minimum Distance Panel Estimates for Waves 2 to 4; Models I to III

**Table A.1:**
**Minimum Distance Panel Estimates for Waves 2 to 4; Models I to III**

| | Model I | | Model II | | Model III | |
|---|---|---|---|---|---|---|
| | Coefficient | t-stat | Coefficient | t-stat | Coefficient | t-stat |
| | | | Earnings Equation | | | |
| Constant | 7.009 | 103.57 | 7.067 | 103.51 | 7.055 | 102.08 |
| YEAR92 | | | 0.047 | 4.34 | 0.050 | 4.43 |
| YEAR93 | | | 0.142 | 11.87 | 0.145 | 11.01 |
| PEXP | 0.076 | 1.67 | 0.002 | 0.05 | 0.006 | 0.13 |
| $PEXP^2$ | -0.015 | -1.92 | -0.004 | -0.55 | -0.005 | -0.61 |
| CASE | 0.056 | 1.34 | 0.041 | 0.98 | 0.029 | 0.70 |
| 8YS | -0.115 | -3.91 | -0.084 | -2.83 | -0.086 | -2.88 |
| MASTER | 0.074 | 2.60 | 0.074 | 2.59 | 0.077 | 2.64 |
| TT_SCHOOL | 0.135 | 5.02 | 0.151 | 5.62 | 0.151 | 5.58 |
| UNI | 0.173 | 3.65 | 0.190 | 4.00 | 0.204 | 4.19 |
| MARRIED | 0.081 | 2.71 | 0.077 | 2.59 | 0.084 | 2.78 |
| N_ORIG | -0.011 | -0.79 | -0.020 | -1.48 | -0.019 | -1.33 |
| PUB_ADM | -0.069 | -3.86 | -0.069 | -3.83 | -0.068 | -3.74 |
| MIN_EP | 0.113 | 3.47 | 0.087 | 2.66 | 0.088 | 2.65 |
| CHEM | 0.054 | 0.85 | 0.020 | 0.32 | -0.014 | -0.20 |
| IR_STEEL | 0.012 | 0.46 | 0.022 | 0.88 | 0.027 | 1.04 |
| M_ENG | 0.009 | 0.34 | -0.001 | -0.03 | 0.002 | 0.09 |
| ELEC | -0.064 | -1.54 | -0.050 | -1.21 | -0.054 | -1.30 |
| TEXTILE | 0.060 | 1.14 | 0.025 | 0.47 | 0.028 | 0.53 |
| F_LX | -0.021 | -0.56 | -0.056 | -1.45 | -0.056 | -1.47 |
| CONSTR | 0.113 | 4.59 | 0.099 | 4.01 | 0.095 | 3.77 |
| TRADE | 0.005 | 0.18 | -0.018 | -0.60 | -0.025 | -0.83 |
| INVSTW | -0.305 | -14.88 | -0.259 | -11.97 | -0.257 | -11.85 |
| EWG | 0.157 | 5.60 | 0.130 | 4.61 | 0.132 | 4.64 |
| EWB | 0.132 | 3.33 | 0.149 | 3.74 | 0.158 | 3.94 |
| D_DISAB | -0.237 | -1.34 | -0.152 | -1.34 | -0.122 | -1.06 |

**Table A.1 (ctd.): Minimum Distance Panel Estimates for Waves 2 to 4; Models I to III**

| | Model I | | Model II | | Model III | |
|---|---|---|---|---|---|---|
| | Employment Equation | | | | | |
| Constant | 0.682 | 7.60 | 0.725 | 7.90 | 0.736 | 7.91 |
| YEAR92 | | | -0.133 | -3.65 | -0.145 | -3.66 |
| YEAR93 | | | -0.172 | -4.03 | -0.186 | -3.99 |
| AGLT30 | 0.004 | 0.04 | 0.132 | 1.33 | 0.161 | 1.57 |
| AG4549 | 0.112 | 1.73 | 0.068 | 1.06 | 0.078 | 1.17 |
| AG5054 | 0.005 | 0.09 | -0.091 | -1.47 | -0.082 | -1.31 |
| AGG55 | -0.505 | -7.56 | -0.522 | -7.77 | -0.511 | -7.34 |
| CASE | -0.279 | -2.12 | -0.103 | -0.77 | -0.070 | -0.51 |
| 8YS | -0.168 | -3.06 | -0.118 | -2.14 | -0.125 | -2.25 |
| MASTER | 0.111 | 1.78 | 0.061 | 0.97 | 0.056 | 0.88 |
| TT_SCHOOL | -0.078 | -1.18 | -0.112 | -1.69 | -0.114 | -1.72 |
| UNI | 0.304 | 2.36 | 0.170 | 1.30 | 0.143 | 1.08 |
| M_WS | 0.205 | 2.37 | 0.320 | 3.65 | 0.316 | 3.56 |
| UNM | -0.008 | -0.08 | 0.102 | 0.98 | 0.116 | 1.10 |
| D_DISAB | -0.649 | -3.41 | -0.572 | -2.98 | -0.606 | -3.14 |
| | Waves 2 to 4 | | Waves 2 to 4 | | Wave 2 | |
| $a_{11}$ | 0.198 | 19.54 | 0.195 | 19.11 | 0.204 | 17.24 |
| $a_{21}$ | 0.630 | 74.10 | 0.621 | 71.35 | 0.629 | 55.39 |
| | | | | | Wave 3 | |
| $a_{11}$ | | | | | 0.189 | 16.21 |
| $a_{21}$ | | | | | 0.618 | 58.52 |
| | | | | | Wave 4 | |
| $a_{11}$ | | | | | 0.191 | 10.48 |
| $a_{21}$ | | | | | 0.619 | 55.36 |
| $\chi^2$ $(d.f.)$ | 495.396 (78) | | 192.900 ( 74) | | 189.485 (70) | |