CESifo *Working Paper Series*

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Working Paper No. 397

December 2000

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Abstract

The purpose of this paper is to evaluate the efficiency of the East German economy at the firm level using an unbalanced panel over the transition period 1994 to 1998. We adopt a translog stochastic frontier model to estimate technical efficiency in eastern and western Germany. The results indicate that firms in eastern Germany are significantly less efficient than firms in western Germany. The paper also examines some of the possible correlates of regional variations in firm-level efficiency.

Keywords: East Germany, technical efficiency, panel data, convergence, wages

JEL Classification: D24, C33, J31, O52

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1. Introduction

On October 3rd 1990 eastern and western Germany were formally united. Despite what politicians claimed, unification was not a merger but a takeover and eastern Germany was forced to adapt overnight a completely new system. Matters were made worse by the decision to set the exchange rate for the East German mark on average at 1.81 to 1 against the West German D-mark.[1] Western Germany was one of the richest, most highly industrialised and technologically advanced market economies in the world; eastern Germany was nearly bankrupt, and economically shattered after 45 years under centrally-planned socialism. This politically motivated exchange rate made East German products much less competitive. At the same time, East Germany´s traditional export markets in the former Soviet bloc collapsed, while East German consumers rushed to western products. Despite these developments, West German politicians assured during the initial euphoria that eastern Germany would be transformed within a matter of years into a „flourishing landscape“ with a standard of living comparable to western Germany. Ten years and the gigantic net transfers (after the deduction of tax revenues collected from the East) of DM 1.2 trillion (about 5 percent of western Germany´s GDP) later, many are wondering what happened to the „flourishing landscapes“.[2] After an initial spurt of rapid transformation following the rapid privatisation of the East German economy by the „Treuhandanstalt“ catching-up appears to have stopped and there exists no „self-sustaining upswing“. In 1991 eastern Germany´s GDP per head was a mere 31 percent of western Germany´s average (see Table 1). Closing that gap has been the stated aim of all German governments ever since, and progress has been swift: in 1998 per capita GDP was 56.1 percent of the western mean. No other eastern European country has made up so much ground in the first years of the transition period. Yet the gap has merely narrowed, not disappeared. Additionally, progress has slowed down. Between 1991 and 1993 eastern Germany narrowed the gap with western Germany in per capita GDP by 16.4 percentage points. In the following three years is shaved off only another 9.1 points, but in the two years after that, to 1998, the gap even increased slightly.[3] At the same time, unemployment stuck at over 19 percent since 1997, is twice western levels. Of course, it is all a matter of the perspective. If one considers where eastern Germany has come from, rather where it is meant to be heading, a much brighter picture emerges. By that yardstick, per capita GDP has almost doubled and thanks to massive western transfers the public infrastructure has been modernised. Finally, the last column in Table 1 indicates that eastern

[1] Politically, this favorable conversion rate was probably justifiable, economically a severe problem. At the time of the fall of the Berlin wall, The East German mark had been exchanging at an official rate of nine to one, and at up to 20 to one on the black market [see Burda and Gerlach (1993) for further details].

[2] All Germans still have to pay an extra 5.5 percent of income tax towards a „solidarity surcharge“ – a supposedly temporary levy introduced in 1991 to help for eastern Germany´s reconstruction. Parts of the transfers are redistributed under the tax revenue-equalisation system („*Länderfinanzausgleich*“) between Germany´s 16 states („*Länder*“) and the federal government.

Germany´s relative unit labour costs in manufacturing have declined substantially over the period 1991 – 1998 because of productivity gains and labour shedding.

Table 1: Macroeconomic Indicators of Catching-Up in Eastern Germany

Year	Per Capita GDP (East/West in %)	Unemployment Rates East	West	Manufacturing Unit Labour Costs (East/West in %)
1991	31.3	10.3	6.3	159.7
1992	38.9	14.8	6.6	139.6
1993	47.7	15.8	8.2	124.4
1994	52.3	16.0	9.2	124.8
1995	55.0	14.9	9.3	120.6
1996	56.8	16.7	10.1	115.9
1997	56.9	19.5	11.0	111.4
1998	56.1	19.5	10.5	108.8

Source: Council of Economic Advisors (1999), Statistisches Bundesamt *Annual Statistical Yearbook 1999*, Wiesbaden and Görzig, B. and G. Noack (1999).

Against this background, the basic aim of this paper is to seek an answer how far East German total factor productivity has converged to West German levels since unification. We also want to get a better understanding of the divergent efficiency patterns across firms. The paper is related to several strands in the literature who have looked at the convergence between East and West Germany. First, the theoretical growth literature on convergence is extensive, and it is discussed for instance in Burda and Funke (1995), Dornbusch and Wolf (1992), Funke and Strulik (2000) and Hughes Hallet and Ma (1993). Second, Barrell and te Velde (2000) and Rothfels (1997) provide empirical evidence for the determinants of the catching-up of East Germany´s labour productivity at the macroeconomic level. Third, a closer antecedent to the analysis here is Bellmann and Brussig (1998) and Fritsch and Mallok (1994). Using survey data from different sources, they provide microeconomic evidence on labour productivity in eastern German manufacturing.[4]

The structure of the remainder of this paper is as follows: Section 2 quantifies the efficiency of firms in eastern Germany. Unlike research that relies on aggregate data, firm-level data are used which exploit variation within industries to identify the parameters of interest.[5] Section 3 provides concluding remarks and offers some implications for economic policy.

[3] The rapid growth over 1991-1995 was largely the result of a boom in construction. When construction growth peaked and then turned negative, growth fell back.
[4] One obvious disadvantage of labour productivity measures is that an increase in labour productivity can result from increases in the capital-output ratio without changes in the underlying technology and efficiency.
[5] The obvious disadvantage of aggregate studies is that aggregate data belie the tremendous amount of dispersion across firms.

2. Estimates of Technical Efficiency

2.1. Specification

The stochastic frontier production function literature has made a significant contribution to the econometric modelling of production and the estimation of technical efficiency of firms. The stochastic frontier involves two random components, one associated with the presence of technical inefficiency and the other being a traditional random error term.[6] This paper considers the translog production functions to benchmark the performance of eastern German firms. This functional form is chosen because it is flexible and imposes few restrictions on the data. In addition, we define the stochastic frontier production function model for panel data, in which technical efficiencies of firms may vary over time. We consider the particular parametric model for the technical inefficiency effects originally suggested by Battese and Coelli (1995). The model assumes that there are N firms over T time periods. The panel of data is allowed to be unbalanced. The stochastic frontier production function which is considered is defined by

$$(1) \qquad y_{it} = \exp\left(x_{it}\beta + v_{it} - u_{it}\right)$$

where y_{it} denotes value added for the i-th firm in the t-th time period, x_{it} represents a $(1\times K)$ vector whose values are functions of inputs, β is a $(K\times 1)$ vector of unknown parameters to be estimated, the v_{it}´s are assumed to be independent and identically distributed random errors which have normal distribution with mean zero and unknown variance σ_v^2, and the u_{it}´s are non-negative unobservable random variables associated with the technical inefficiency of production, such that, for the given level of technology and levels of inputs, the observed output falls short of its potential output. The v-errors account for measurement errors in inputs and outputs and the effects of misspecification in the production technology. The u-error is associated with technical inefficiency of production.[7] The u-errors are defined by

$$(2) \qquad u_{it} = z_{it}\delta + w_{it}$$

where z_{it} is a $(1\times M)$ vector of explanatory variables associated with the technical inefficiency effects, δ is an $(M\times 1)$ vector of unknown parameters to be estimated, and the w_{it}´s are unobservable random variables which are assumed to be independently distributed, obtained by truncation of the

[6] Excellent surveys of the literature on econometric estimation of frontier production functions and efficiency measurement are available in Coelli et al. (1998) and Kumbhakar and Lovell (2000).

[7] The stochastic nature of the model allows some observations to lie above the production function, which mekes the model less vulnerable to the influence of outliers than deterministic frontier models.

normal distribution with mean zero and unknown variance σ^2, such that u_{it} is non-negative (i.e. $w_{it} \geq - z_{it}\delta$). An important feature of equation (2) is that the technical inefficiency effects are modelled in terms of various explanatory variables. Given the specification in (1) and (2), technical efficiency is defined by

(3) $$TE_{it} = \exp\left(-u_{it}\right)$$

which indicates that the technical efficiency is no greater than one (one hundred percent). Given the specification in (2), the null hypothesis that the technical inefficiency effects are not random is expressed by H_0: $\gamma = 0$ where $\gamma = \sigma^2/(\sigma_v^2 + \sigma^2)$. Further, the null hypothesis that the technical inefficiency effects are not influenced by the level of the explanatory variables in (2) is expressed by H_0: $\delta' = 0$ where δ' denotes the vector δ, with the constant term, δ_0, omitted, given that it is included in the expression $z_{it}\delta$. Finally, the null hypothesis that the second-order coefficients in the translog function are zero tests whether the Cobb-Douglas function applies. Tests of these alternative hypotheses are obtained using the generalised LR statistic.

2.2. Functional Forms and Variables

In this study, the most general functional form for the stochastic frontier is the value added translog function

(4) $$\ln y_{it} = \beta_0 + \sum_{j=1}^{2} \beta_j x_{jit} + \sum_{j \leq}^{2} \sum_{k=1}^{2} \beta_{jk} x_{jit} x_{kit} + v_{it} - u_{it}$$

where the subscripts i and t represent the i-th firm and the t-th year of observation, respectively. y represents the log of value added, x_1 is the log of the number of employees, and x_2 is the log of the book value of fixed assets (stocks of machinery, buildings and land).[8] v_{it} and u_{it} are random variables as defined above. The Cobb-Douglas production function is a special case of the translog frontier in which the coefficients of the second-order terms are zero, i.e., $\beta_{jk} = 0$, $j \leq k = 1,2$. The model for the technical inefficiency effects in the stochastic frontier is defined by

(5) $$u_{it} = \delta_0 + \delta_1 D_1 + \sum_{i=2}^{n} \delta_i D_i + w_{it}$$

[8] Capital stocks are difficult to measure at the firm level and therefore efficiency indices may be contaminated by measurement error. Fortunately, Baily et al. (1992) have found that productivity dispersion and evolution do not change significantly when more sophisticated measures of fixed assets are used instead of crude measures based on book values.

where D_1 is a dummy variable for eastern Germany which has value one if the firm is located in eastern Germany, and zero otherwise. D_i (i = 2, ..., n) are three-digit industry dummy variables. The industry dummies have been added to account for general effects caused by the sector-specific environment. We have restricted the analysis to three industries (mechanical engineering, chemicals, utilities) where a sufficient number of observations for the new *Länder* was available within *Amadeus*. The annual firm-level data cover the period from 1994 to 1998.[9] The sample covers a wide range of firms with regard to size, location and other characteristics. The dataset, however, is not equilibrated across regions, i.e. there is some bias in coverage. A basic summary of the values of the variables in our data set is listed in Table 2.

Table 2: Summary Statistics of the Relevant Variables in the Stochastic Frontier Model
(Average Values During the Sample Period)

	West Germany		East Germany		Germany	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Mechanical Engineering						
N	221		17		238	
y	307268	1105498	42225	25385	288336	1067326
x_1	2638	9823	484	250	2484	9481
x_2	243830	1090260	34776	33064	228897	1051850
Chemicals						
N	292		22		314	
y	345903	1560005	65157	97366	326233	1506105
x_1	2177	9691	657	1095	2070	9357
x_2	499913	2367719	160114	410980	476105	2287124
Utilities						
N	310		67		377	
y	189953	488156	100455	215882	174048	452977
x_1	795	1818	615	1409	763	1752
x_2	570084	1562741	501007	1140960	557808	1495391

Notes: The monetary variables are measured in thousands of Deutschmark. Labour (x_1) is given by the number of employees.

2.3. The Evidence

The dataset underlying the empirical work allows to provide information about average efficiency levels as well as the heterogeneity of efficiency across firm in eastern and western Germany. Is the

[9] All data were taken from the *Amadeus* database (© Bureau van Dijk) of the top 200,000 European companies. The database offers standardised financial data (balance sheets and profit & loss account data). German companies are included when they comply with one of the three following citeria: (1) operating revenues equal to at least 10 million € ; (2) total assets equal to at least 20 million € ; (3) number of employees equal to at least 150. We have deleted firms that fail to meet a standard set of criteria for data

economic landscape in eastern Germany highly skewed and divided into a few very efficient firms on the one hand and a large number of rather inefficient firms on the other hand? Furthermore, is the economic landscape in western Germany characterised by less variation of efficiency measures across firms? The stochastic frontier production model is estimated separately for each of the three industries. Maximum-likelihood estimates of the parameters of the translog stochastic frontier production function (4), given the specification for the technical inefficiency effects, defined by equation (5), are given in Table 3.[10] Test statistics and measured levels of average industry-wide efficiency levels in eastern and western Germany are reported in Table 4 and 5, respectively. To economise on space, we will not display the entire regression output of each of the 27 sector dummies.

Table 3: ML Estimates for Parameters of Translog Stochastic Frontier Production Functions For Three German Industries

Variable	Mechanical Engineering	Chemicals	Utilities
Frontier Function			
Constant	6.10 (28.58)	8.18 (29.12)	10.55 (32.62)
Labour	0.48 (8.37)	0.97 (12.46)	1.44 (18.02)
Capital	0.11 (2.74)	-0.55 (-8.51)	-1.24 (-16.41)
(Labour)²	0.06 (9.08)	0.06 (7.84)	0.07 (13.22)
(Capital)²	0.02 (6.69)	0.06 (11.20)	0.10 (22.43)
Labour × Capital	-0.05 (-7.29)	-0.09 (-7.82)	-0.15 (-17.26)
Inefficiency Model			
Constant	-8.01 (-4.76)	-3.56 (-4.64)	-7.42 (-6.99)
D_1	6.27 (5.91)	4.01 (6.79)	6.30 (8.21)
Variance Parameters			
$\gamma = \sigma^2/(\sigma_v^2 + \sigma^2)$	0.96 (99.63)	0.86 (39.63)	0.96 (169.41)
$\sigma_v^2 + \sigma^2$	1.67 (5.80)	1.11 (7.14)	1.62 (8.66)
Log-Likelihood	-341.17	-783.08	-567.18

Notes: The parameters of the 27 industry dummies variables (mechanical enginerring: (1) mechanical engineering, (2) agricultural machinery, (3) metal working machinery, (4) textile machinery, (5) machines for the food industry, (6) mining machinery, (7) mechnaical power transmission machinery, (8) equipment for the printing, paper and glass industry, (9) other machinery, (10) military equipment production; chemicals: (1) Basic industrial chemicals, (2) paints, varnishes and pronting ink, (3) chemical products for agricultural

quality. We have also eliminated firms with many missing variables from the original database. Not all years are available for all firms. A firm list is provided upon request.

[10] The parameters of the model defined by (4) and (5) are estimated simulataneously using the computer program FRONTIER 4.1 written by Coelli (1996). The program can be downloaded from the Internet at www.une.edu.au/econometrics/cepa.htm. The efficiency levels of individual firms have been omitted for parsimony but are available upon request.

purposes, (4) pharmaceutical products, (5) Soap preparations, (6) chemical products for household purposes, (7) fibre production, (8) glass production, (9) building products, (10) ceramics, (11) wood industry, (12) paper industry, (13) plastic industry; utilities: (1) nuclear fuel production, (2) production and distribution of electricity, (3) public gas supply, (4) water supply industry) are not individually reported. Tests of the joint significance of the industry dummies are presented in Table 5. *t*-values are given in parentheses. All variables, except the dummy variables, are in logarithms, as specified in (4).

Table 4: Likelihood-Ratio Tests for Parameters in the Frontier Production Function Model

Null Hypothesis	Model			Critical Value
	Mechanical Engineering	Chemicals	Utilities	
$\beta_{ik} = 0$ j,k = 1, 2 (Cobb-Douglas)	200.26	283.74	592.83	7.81
$\gamma = \delta_0 = \delta_1 = ... \delta_{13} = 0$ (no inefficiency effects)	165.89			24.38
$\gamma = \delta_0 = \delta_1 = ... \delta_{11} = 0$ (no inefficiency effects)		307.95		21.74
$\gamma = \delta_0 = \delta_1 = ... \delta_4 = 0$ (no inefficiency effects)			494.94	11.91
$\delta_2 = \delta_3 = ... \delta_{13} = 0$ (no industry effects)	6.35			22.4
$\delta_2 = \delta_3 = ... \delta_{11} = 0$ (no industry effects)		59.12		19.7
$\delta_2 = \delta_3 = \delta_4 = 0$ (no industry effects)			20.16	9.49
$\delta_1 = 0$ (no East-West effect)	73.09	102.63	231.60	3.84

Notes: Values of the generalised LR-statistic are given in the body of the Table. The test statistics are approximately χ^2 with degrees of freedom equal to the difference between the parameters involved in the null and alternative hypothesis. In the case $\gamma=\delta_0=\delta_1=..\delta_n=0$, the statistic is distributed according to a mixed χ^2 distribution. In this case, critical values are obtained from Table 1 in Kodde and Palm (1986). Values which exceed the 5% critical value in the Table are significant.

The signs of most β-estimates in Table 3 are as expected and statistically significant. In all three sectors, the parameter γ is estimated close to 1.0, suggesting that the technical inefficiency effects are significant. Finally, the estimates of D_1 in the inefficiency model indicate that there exists a significant locational disadvantage of eastern Germany. Several LR-tests are presented in Table 4. The first test considers the frontier production function. Given the translog technology, the Cobb-Douglas model is strongly rejected in all three sectors. The remaining tests consider restrictions on the parameters in the inefficiency model. The industry dummy effects differ across sectors. The joint test of no industry effects is accepted for mechanical engineering, but rejected for chemicals and utilities. The magnitudes of these effects are, however, rather small. This implies that idiosyncratic firm-level factors essentially dominate within-industry heterogeneity.[11] The resulting mean efficiency scores are displayed in Table 5 below.

[11] Haltiwanger (1997) has shown that in the US 4-digit industry-effects account for less than 10 percent of the cross-sectional variation in firm-level performance.

Table 5: Mean Levels of Efficiency in Eastern and Western Germany, 1994 - 1998

	Mean Levels of Efficiency			Coefficient of Variation	
	West	East	East/West in %	West	East
Mechanical Engineering					
1994	0.83	0.52	62	0.10	0.40
1995	0.84	0.55	66	0.11	0.36
1996	0.84	0.59	70	0.11	0.29
1997	0.85	0.67	79	0.11	0.26
1998	0.84	0.75	89	0.12	0.15
Chemicals					
1994	0.84	0.55	66	0.10	0.48
1995	0.84	0.61	73	0.09	0.38
1996	0.84	0.60	71	0.12	0.44
1997	0.85	0.62	73	0.09	0.43
1998	0.85	0.62	73	0.08	0.39
Utilities					
1994	0.84	0.55	65	0.10	0.38
1995	0.85	0.59	70	0.12	0.33
1996	0.85	0.61	72	0.10	0.33
1997	0.86	0.63	74	0.07	0.24
1998	0.86	0.67	78	0.09	0.23

A number of features are evident. First, and most significant, firms in eastern Germany are significantly less efficient than firms located in western Germany.[12] Broadly speaking, this result is consistent with the hypothesised size-efficiency and age-efficiency relationships in Jovanovic (1982) model. Second, there are notable differences across sectors. In sectoral terms, East German efficiency is highest in mechanical engineering. This may reflect the fact that there exists now a flotilla a very competitve medium-sized engineering *Mittelstand* firms in eastern Germany. The average efficiency scores in Table 5 give a first impression but they say nothing about the heterogeneity across firms. The histograms in Figure 1 indicate that the amount of efficiency dispersion is extremely large - some firms are substantially less productive relative to best-practice firms within the same sector.[13] Furthermore, when comparing the heterogeneity across eastern and western German firms, it is apparent that the efficiency levels in western Germany are considerably more homogeneous than those in eastern Germany.[14] This again implies that aggregate

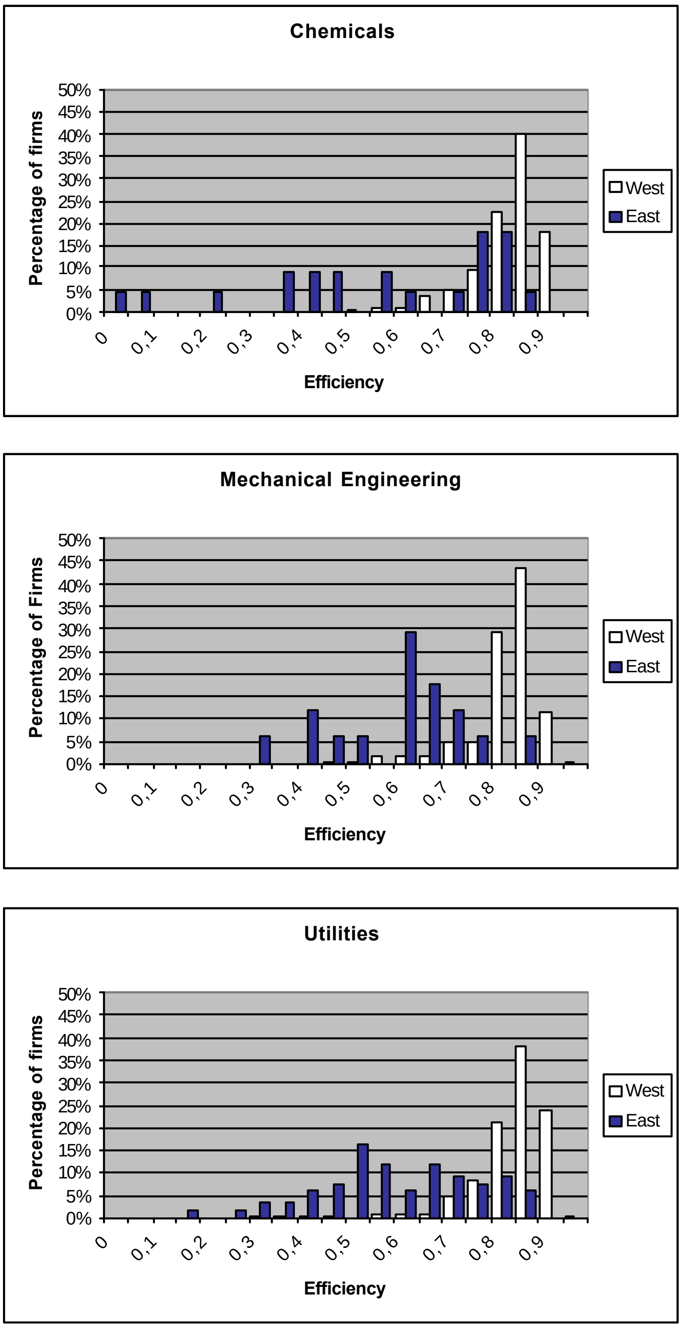
[12] In Table 5, mean technical efficiency is measured by the arithmetic averages. An alternative measure would be a weighted average where the weights are proportional to the size of the firms involved.

[13] Figure 5 has been plotted using the average efficiency scores of each firm over the sample period. An examination of the literature suggests that these striking results are consistent with the magnitude of productivity differences in well functioning market economies like the US and the UK. Olley and Pakes (1996), for example, have found TFP ratios of 3 to 1 within manufacturing. Oulton (1998) has found even more dispersion for the UK. Theoretical models in industrial organisation offer explanations for the dispersion of efficiency across firms. Ericson and Pakes (1995), Lambson (1994), Lucas (1978), Jovanovic (1982) have developed frameworks in which industries are not composed of representative firms but of firms that have different efficiency endowments. These models can be used to analyse within-industry efficiency dynamics.

[14] The larger heterogeneity of firms in eastern Germany is consistent with increasing regional differences in average per capita incomes in eastern Germany [see, Council of Economic Advisors (1999), pp. 72-84].

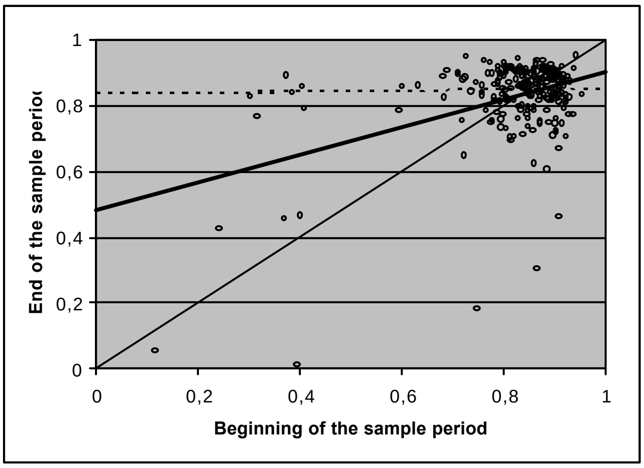
macroeconomic data can only provide a limited impression of the economic situation during the transition process.

Figure 1: The Distribution of Efficiency Levels Across Firms



Next we investigate the dynamics of efficiency. Recent research has demonstrated a high degree of persistence in the dynamics of firm productivity. Baily et al. (1992), for example, have demonstrated for American firms that plants initially in the two top productivity quintiles were still ranked far above average ten years later. What are the facts of this matter in our dataset? Does efficieny across firms converge? Figure 2-4 show efficiency in 1994/95 on the horizontal axis, firm by firm, and efficiency levels in 1997/98 on the vertical axis. Each firm´s experience is summarised by a single observation. For the majority of firms a high degree of efficiency persistence is apparent. The calculated Spearman´s rank correlations turn out to be 0.75, 0.76 and 0.80 for the chemical industry, mechanical engineering and utilities, respectively. On the other hand, there turns out to be a fair amount of change in the efficiency distribution for some firms.[15] In the convergence scatterplots, efficiency improvements and deteriorations are shown by the distance of each observation from the 45° line. Dots above the 45° line indicate efficiency improvements, dots below the line indicate efficiency deterioration. The regression lines through the scatterplot turn out to be flatter than the 45° line which implies that there is weak evidence for „β-convergence“ in efficiency levels.[16]

Figure 2: The Dynamics of Efficiency in the Chemical Industry



[15] This feature might be explained by the type of labour force and capital stock that a firm carries into the future. This leads to heterogeneous responses to shocks.

[16] Given the potential importance of outliers we have calculated the regression lines by OLS and with a robust estimation technique. The robust estimation technique carries out robust fitting with bisquare weights. This is a form of weighted least squares where outlying observations are given relatively less weight in estimating the coefficients of the regression [see Cleveland (1993) for additional discussion]. The solid lines in Figure 2-4 give the OLS estimates, the dashed lines give the robust estimates. Nevertheless, for statistical reasons, the patterns displayed in Figure 2-4 should probably be taken with a grain of salt.

Figure 3: The Dynamics of Efficiency in Mechanical Engineering

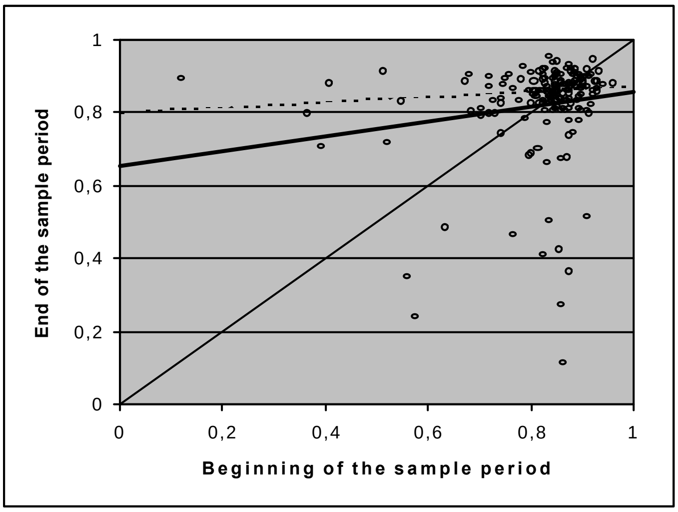
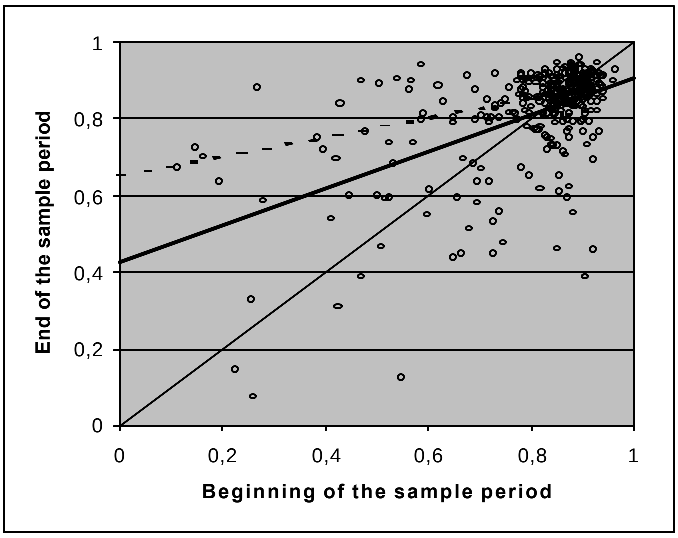


Figure 4: The Dynamics of Efficiency in Utilities

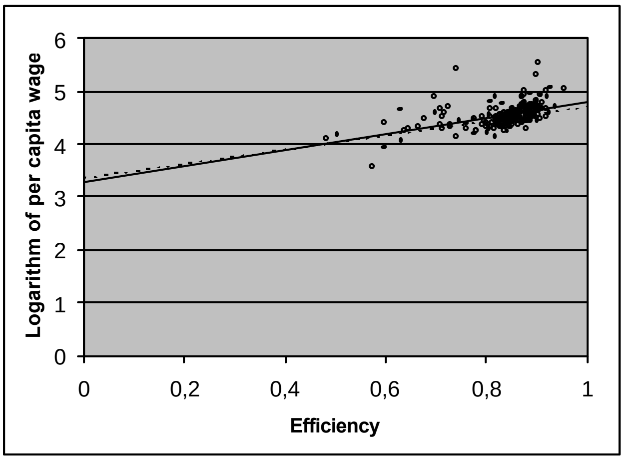


Given our finding that efficiency varies significantly across firms and regions, an obvious issue is whether these differences are associated with per capita wages. In this context, attention has recently focused on the „flexibility" of the German labour market and its ability to adapt and adjust to the inevitable competitve pressures that unification has generated. There is great concern that the German labour markets are a classical example of an „old economy".[17] German wage formation is mainly geared to the interests of „insiders" who already have a job and not to those „outsiders" who would prefer moderate and more differentiated wage settlements. As a result, Europe has failed to create jobs in the same way as the more flexible American economy. The accelerated

[17] See Siebert (1992), 124-128 and Council of Economic Advisors (1993), 235-236. Prasad (2000) has recently shown that the German bargaining system has fostered a relatively inflexible wage structure.

adjustment of East German wages to the West German standards is one frequently cited example of insufficient wage differentiation. On the other hand, important changes to the traditional German system of collective bargaining are well under way. The industry-wide coverage of collective agreements, and the limited differentiation of wages by job category and region meant that the system paid scant attention to the ability to pay of individual firms. This was at its most extreme in eastern Germany, where collective agreements forced wage harmonisation on low productivity enterprises with obsolent capital stock. Recently, however, collective bargaining systems have changed in the West and have been bypassed in the East. In 1995 greater flexibility was introduced by settlements in the chemical and engineering industries, which, through so-called „hardship clauses", permitted firms in difficulty to recruit at less than the tariff wage. Likewise, lower wages and saleries could be paid under opening clauses (*„Öffnungsklauseln"*) to the long-term unemployed who were recruited. Since 1997, greater flexibility has been offered to firms in reaching firm-based agreements within the collective agreement. In eastern Germany, collective agreements nowadays appear the exception rather than the rule. In order to survive during the transition period, many firms left the employers´ associations, and newly created firms did not join. In East Germany´s engineering industries, for example, only about 30 percent of firms are covered by a collective agreement. On the contrary, about two-thirds of employees in western Germany in this sector have some coverage under a collective agreement. Additionally, job-protection laws have been loosened. Yet, despite these claims, surprisingly little is actually known about regional wage flexibility. From an empirical perspective, it therefore remains an open question to what extent firm-level wages are linked to firm-level efficiency levels.[18]

Figure 5: The Relationship Between the Logarithm of Per Capita Wages and Efficiency for the Entire Sample of West German Mechanical Engineering Firms



According to the OECD (1994), it is those economies with less flexible labour markets and greater wage rigidities which appear likely to experience greater persistence in unemployment.

[18] Again the solid (dashed) lines indicate the OLS (robust regression) estimates.

Figure 6: The Relationship Between the Logarithm of Per Capita Wages and Efficiency for the Entire Sample of East German Mechanical Engineering Firms

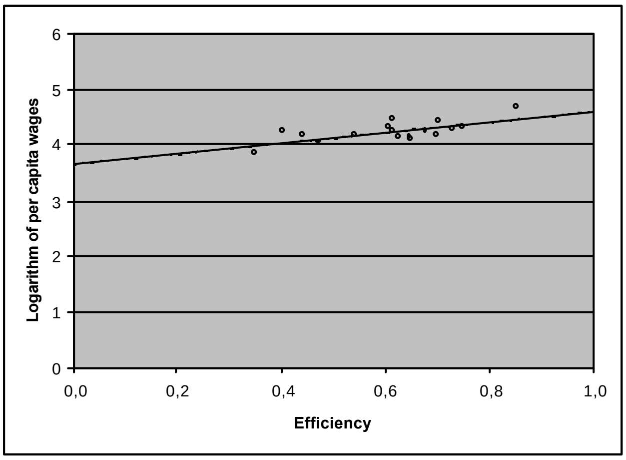


Figure 7: The Relationship Between the Logarithm of Per Capita Wages and Efficiency for the Entire Sample of West German Chemical Industry Firms

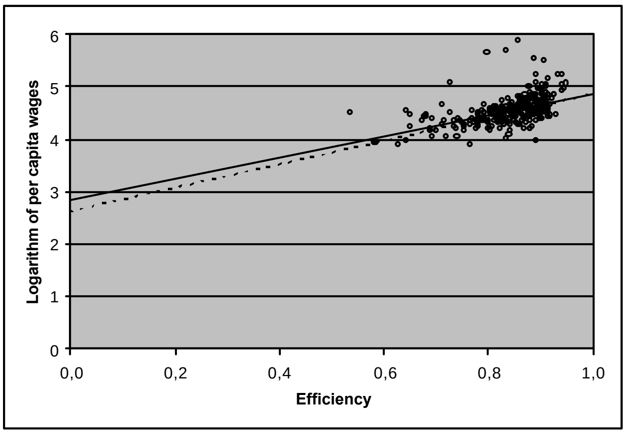


Figure 8: The Relationship Between the Logarithm of Per Capita Wages and Efficiency for the Entire Sample of East German Chemical Industry Firms

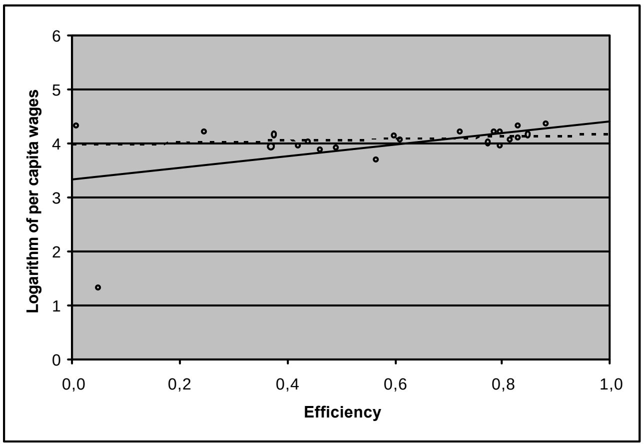


Figure 9: The Relationship Between the Logarithm of Per Capita Wages and Efficiency for the Entire Sample of West German Utility Firms

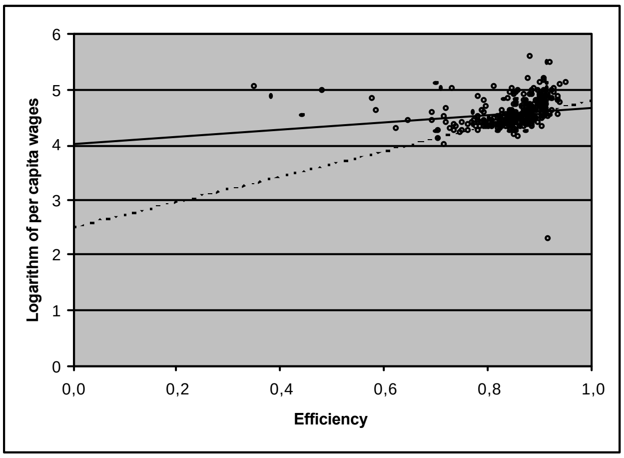
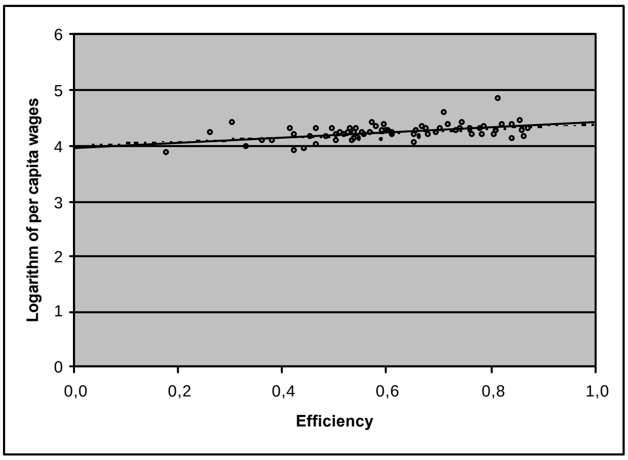


Figure 10: The Relationship Between the Logarithm of Per Capita Wages and Efficiency for the Entire Sample of East German Utility Firms



The hypothesis about a positive correlation between efficiency levels and per capita wages is confirmed for eastern and western Germany. This implies that the dispersion in efficiency measures appears quite plausible when examined in conjunction with wages. It is, however, the case that the regression lines turn out to be even flatter in eastern Germany than in western Germany. This implies that the empirical evidence in Figure 5-10 does provide evidence for the conventional wisdom that the unemployment difference between eastern and western Germany is due in part to the greater degree of firm-level wage inflexibility in eastern Germany.[19] The results of our empirical analysis have important implications for economic policy. The weak link between efficiency and wages in eastern Germany (and to a smaller extent in western Germany as well) is

[19] The slopes in eastern Germany turn out to be significantly flatter in chemicals and utilities (at the 5% level). Nickell (1998) has recently singled out several possible factors as potentially influencing different degrees of wage flexibility while Funke and Strulik (2000) have recently demonstrated the importance of wage behaviour for convergence.

clearly undesirable from an allocative point of view and has resulted in sharp declines of employment. The implication is that collective bargaining system should allow for more changes in the wage structure brought about by the restructuring process in eastern Germany.[20] What this rather exploratory analysis also suggests is the need for a much more detailed investigation of the firm and labour market characteristics in different regional and local labour markets. This marks out a future research agenda.

3. Concluding Remarks

In this study we have focused on the efficiency of firms in eastern Germany. The estimates indicate that eastern Germany´s relative efficiency scores have increased substantially over the period 1991 – 1998 because of productivity gains and labour shedding. Nevertheless, East German firms are significantly less efficient in 1998 than West German firms. Thus, there is still some way to go in attaining West German standards of efficiency and competitiveness. This finding is broadly consistent with other studies of East German manufacturing. Reasons for these differences in technical efficiency merit further study. Some of the factors that are thought of determining efficiency include technology, innovation activities, international exposure, quality of the workforce and ownership structure. Another explanation is that technical efficiency is positively related to firm age. New firms are unaware of their abilities and need time to decide on their optimal size. Over time, the least-efficient firms exit, leaving a technically more efficient population of firms.[21] Another finding is that the wage-efficiency relationship is eastern Germany is even weaker than in western Germany. What do all these findings now imply for future growth prospects? The labour market obviously remains a cause for concern. Unification saddled the region with a currency whose value reflected western Germany´s highly productive industry. And employers worsened that handicap by agreeing to raise East German wages to western levels far more rapidly than the productivity gap could be closed.[22] Labour market institutions can also be blamed for causing high unemployment in eastern Germany. Generous unemployment benefits, active labour market programmes, and the role of trade unions in wage negotiations have contributed to raise wages above market-clearing levels and thus to lead to high unemployment.

[20] FitzRoy and Funke (1994) provide econometric evidence for the real wage elasticity of labour demand for skilled and unskilled blue-collar workers in eastern and western Germany. It is sometimes argued that more flexible labour markets may, at least in the short-run, dampen labour productivity growth. But in the long-run a livelier labour market will probably improve Germany´s growth prospects, just as it has done in the United States.

[21] For preliminary evidence on eastern Germany, see Bellmann and Brussig (1998), Carlin and Mayer (1995), Eickelpasch (1998), Fritsch and Mallok (1994) and Rothfels (1997). Most of this research, however, is limited to showing correlations and does not determine causality.

[22] The extension of the western wage bargaining system to eastern Germany, with the attendent harmonisation of wages on western levels, is generally agreed to have contributed greatly to unemployment in eastern Germany [see Sinn and Sinn (1993)].

But there are also encouraging signals. The most important way to make labour more productive is to give them more up-to-date capital. Eastern Germany´s manufacturing capital intensity (gross fixed capital stock per employee) has increased from 30.3% of the western level in 1991 to 88.6% in 1998.[23]

[23] See Görzig and Noack (1999).

References

Baily, N.E., Hulten, C. and D. Campbell (1992) „The Distribution of Productivity in Manufacturing Plants“, *Brookings Papers on Economic Activity: Microeconomics*, 187-249.

Barrell, R. and D.W. te Velde (2000) „Catching-Up of East German Labour Productivity in the 1990s“, *German Economic Review* 1, 271-297.

Battese, G.E. and T.J. Coelli (1995) „A Model for Technical Inefficiency in a Stochastic Frontier Production Function for Panel Data“, *Empirical Economics* 20, 325-332.

Bellmann, L. and M. Brussig (1998) „Ausmaß und Ursachen der Produktivitätslücke ostdeutscher Betriebe des Verarbeitenden Gewerbes“, *Mitteilungen aus der Arbeitsmarkt- und Berufsforschung* 31, 648-660.

Burda, M. and M. Funke (1995) „Eastern Germany: Can´t We Be More Optimistic?“, *Ifo-Studien* 41, 327-354.

Burda, M. and S. Gerlach (1993) „Currency Union and Exchange Rate Dynamics: The Case of the OM-DM Rate“, *Empirical Economics* 18, 417-429.

Carlin, W. and C. Mayer (1995) „Structure and Ownership of east German Enterprises“, *Journal of the Japanese and International Economies* 9, 426-453.

Cleveland, W.S. (1993) *Visualizing Data*, New York (Hobart Press).

Coelli, T.J. (1996) „A guide to FRONTIER 4.1: A Computer Program for Frontier Production Function Estimation“, Department of Econometrics, University of New England, CEPA Working Paper No. 96/07.

Coelli, T.J, D.S.P. Rao and G.E. Battese (1998) *In Introduction to Efficiency and Productivity Analysis*, Boston (Kluwer Academic Publishers).

Council of Economic Advisors [Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung] (1993) *Zeit zum Handeln – Antriebskräfte stärken*, Annual Report 1993/1994, Stuttgart.

Council of Economic Advisors [Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung] (1999) *Wirtschaftspolitik unter Reformdruck*, Annual Report 1999/2000, Stuttgart.

Dornbusch, R. and H. Wolf (1992) „Economic Transition in Eastern Germany“, *Brookings Papers on Economic Activity*, 1:1992, 235-261.

Eickelpasch, A. (1998) „Enterprise Restructuring in East Germany“, *Economic Survey of Europe No. 2*, UN Commission for Europe, 111-132.

Ericson, R. and A. Pakes (1995) „Markov Perfect Industry Dynamics: A Framework for Empirical Work“, *Review of Economic Studies* 62, 53-82.

FitzRoy, F. and M. Funke (1994) „Skills, Wages and Employment in Eastern and Western Germany“, *Regional Studies* 32, 459-467.

Fritsch, M. and J. Mallok (1994) „Die Arbeitsproduktivität des industriellen Mittelstandes in Ostdeutschland – Stand und Entwicklungsperspektiven“, *Mitteilungen aus der Arbeitsmarkt- und Berufsforschung* 27, 53-59.

Funke, M. and H. Strulik (2000) „Growth and Convergence in a Two-Region Model of Unified Germany“, *German Economic Review* 1, 363-384.

Görzig, B. and G. Noack (1999) *Vergleichende Branchendaten für das verarbeitende Gewerbe in Ost- und Westdeutschland*, Berlin.

Haltiwanger, J. (1997) „Measuring and Analyzing Aggregate Fluctuations: The Importance of Building from Microeconomic Evidence“, *Federal Reserve Bank of St. Louis Economic Review* 79, No. 3, 55-77.

Hughes Hallet, A. and Y. Ma (1993) „East Germany, West Germany and Their Mezzogiorno Problem: A Parable for European Economic Integration“, *Economic Journal* 103, 416-428.

Jovanovic, B. (1982) „Selection and Evolution of Industry“, *Econometrica* 50, 25-43.

Kodde, D.A. and F.C. Palm (1986) „Wald Criteria for Jointly Testing Equality and Inequality Restrictions“, *Econometrica* 54, 1243-1248.

Kumbhakar, S.C. and C.A.K. Lovell (2000) *Stochastic Frontier Analysis*, Cambridge (Cambridge University Press).

Lambson, V. (1991) „Industry Evolution with Sunk Costs and Uncertain Market Conditions“, *International Journal of Industrial Organisation* 9, 171-196.

Lucas, R.E. (1978) „On the Size Distribution of Business Firms“, *Bell Journal of Economics* 9, 508-523.

Nickell, S. (1998) „Unemployment: Questions and Some Answers“, *The Economic Journal* 108, 802-816.

OECD (1994) *The OECD Jobs Study*, Paris.

Olley, G.S. and A. Pakes (1996) „The Dynamics of Productivity in the Telecommunications Equipment Industry“, *Econometrica* 64, 1263-1297.

Oulton, N. (1998) „Competition and the Dispersion of Labour Productivity Amongst UK Companies“, *Oxford Economic Papers* 50, 23-38.

Prasad, E.S. (2000) „The Unbearable Stability of the German Wage Structure: Evidence and Interpretation“, *IMF Working Paper No. WP/2000/22*, Washington.

Rothfels, J. (1997) „Die ostdeutsche Wirtschaftsstruktur und die Produktivitätslücke“, *Wirtschaft im Wandel* 13, 15-21.

Siebert, H. (1992) *Das Wagnis der Einheit – Eine wirtschaftspolitische Therapie*, Stuttgart.

Sinn, G. and H.-W. Sinn (1993) *Jumpstart*, Cambridge/Mass. (MIT Press).