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# Skills, Wages, and Employment in East and West Germany

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## Abstract

Disaggregated data from 30 two-digit manufacturing industries in the east and west parts of unified Germany are used to estimate employment for three skill categories of blue collar workers. Employment elasticities are uniformly higher in the east, and for unskilled labor. The former result contradicts union claims that wages had little relevance for east German job losses, while the latter confirms the capital-skill complementarity hypothesis.



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E24, J23

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1/ Professor FitzRoy is at the University of St. Andrews, and Professor Funke is at Humboldt University. This paper was prepared while Professor Funke was a Visiting Scholar in the Research Department of the International Monetary Fund. He is grateful for the hospitality of the Fund and comments and suggestions received from colleagues there. The authors would like to thank Carolin Weitzman for excellent research assistance. The views expressed are the authors' alone and do not necessarily represent the views of the International Monetary Fund.

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## Summary

Since unification, the economy of eastern Germany has undergone rapid changes in response to the shift in trading patterns away from the Council for Mutual Economic Assistance countries, the liberalization of prices, and privatization. One result has been a fall in overall manufacturing employment of about 65 percent in 1991-93. At the same time, equity concerns have led to a sharp increase in wages in eastern Germany, from about 30 percent to 60 percent of western German levels. Both the shift in industrial composition and the wage increases should, in principle, have contributed to the employment decline.

This paper quantifies the factors affecting labor demand in eastern Germany by estimating a dynamic model of labor demand that treats skilled, semiskilled, and unskilled workers as different factor inputs having potentially different degrees of complementarity with capital. The model is also estimated for western Germany, which has a substantially different production structure and employment history.

The results show that labor demand in eastern Germany is responsive to wage rates, even more so than in the west. This finding contradicts union claims that the policy of raising eastern German wages toward western levels has not been a major contributor to employment declines. Moreover, capital and skill appear to be complements in production, implying that unskilled labor was much more affected by the wage increases than skilled labor.

These results have implications beyond the eastern German labor market. The skill-capital complementarity means that unskilled labor in developed economies is particularly vulnerable to competition from low-wage labor in developing countries. This observation lends support to the hypothesis that unemployment in the United States has been held down by a widening of the wage distribution, particularly at the low end. By contrast, in Europe, the same factors, together with a more compressed wage structure, appear to have resulted in higher unemployment and less labor force participation (that is, an increase in the number of discouraged workers), particularly among the unskilled.

## I. Introduction

It is widely believed that demand for unskilled labor is more responsive to wage changes than skilled employment. Some form of capital-skill complementarity seems to be a plausible explanation. Suggestive support for this hypothesis comes from comparison of recent experience in continental Europe and the United States. In America, declining unionization and decentralized bargaining have accompanied rapid job-generation, but much of it at low pay and skill levels. The wage distribution has thus become more unequal in the last decade. In Europe by contrast, centralized bargaining has maintained more uniform wages, with higher rates for the unskilled and services, while unemployment remains much higher, specially for the unskilled. Britain seems to have the worst of both worlds, with high unemployment as well as increasing wage dispersion in deregulated labor markets.

Many other factors, such as the level and duration of unemployment benefits and retraining programs, are of course relevant. However, as labor market policy and persistently high unemployment have become major policy issues in the European Union, it is surprising that very few quantitative studies of wage-employment elasticities between skill categories have been done. Nissim (1984) and Schulte zur Surlage (1985) find the expected differences, but use rather limited time series with all the problems of commonly trended nonstationary variables. Further studies for particular industries are reviewed by Hamermesh (1993). FitzRoy and Funke (1992) find evidence for capital-skill complementarity using data for west Germany.

In this paper we add another dimension to the comparison of employment elasticities across skills. The dramatic decline of manufacturing employment in eastern Germany after reunification has been accompanied by a major "wage push" that has brought eastern wages from about 30 percent to about 60 percent of west German levels. Union leaders have defended this wage policy on equity grounds and claimed that collapsing demand in the former COMECON and the shift of east German consumers to western goods were responsible for the collapse of employment. It is thus of interest to try to estimate the respective contributions of these different factors to east German employment and compare the responses of different skill groups. In addition we estimate wage-employment elasticities for west German manufacturing over the same post-unification time period, and so we can compare results from two economies, which (still) differ greatly in terms of factor endowments, factor quality and factor prices. This comparison also provides an additional test of a simple model of labor demand.

The plan of the paper is to describe the main feature of the data and the differing institutional backgrounds of east and west Germany since unification in Section II. In Section III a simple dynamic model of labor demand is developed. Estimation issues and the empirical results are presented in Section IV. The paper concludes with a discussion of policy issues relating to our results in a final Section V.

## II. Data and Institutional Background

Data for the east part of unified Germany are available only from 1991. Quarterly data for 30 manufacturing industries are available on a comparable basis for east and west Germany from 1991:1 to 1993:4. The data include employment of blue-collar production workers in the three standard classifications (skilled, semiskilled and unskilled), their respective wages, net output (value added), and the producer price index. 1/ To present the main developments over this period, the aggregate manufacturing data are summarized in Tables 1 and 2 for east and west Germany, respectively. The aggregate movements conceal wide variations in employment and output, so Figure 1 and Figure 2 display initial and final employment in each sector for each part of Germany.

As can be seen from Table 1, the interregional differences in employment and output over the 1991-1993 period are far from small. 2/ The most dramatic shift is perhaps the drop in aggregate eastern employment by about 65 percent from 1991:1 to 1993:4. Figures 1 and 2 show the wide variation in job losses across industries and the much greater overall losses in the east.

The background to the wage developments in east Germany over our sample period is also of interest. Before privatization had advanced significantly, initial collective bargaining was conducted between west German unions (in the absence of legitimate union representatives in east Germany), and managers of the existing large state-owned enterprises. As is well known, a succession of wage increases to the western level was agreed in the initial round of negotiations. 3/ The unions' defense of these much criticized agreements was fourfold. First, equity and solidarity required rapid attainment of parity. Second, persistent inequality encourages continued migration to the west, with damaging social consequences. Third, declining labor demand was caused by the collapse of eastern Europe's markets and would not be affected by wages. Fourth, higher paid workers who lose their jobs receive correspondingly higher unemployment benefits and pensions, thus providing further motivation for wage-push in spite of growing unemployment. Another possible hidden agenda was that

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1/ All data are defined in the Appendix.

2/ One very important development is not captured in these descriptive statistics. Comparable industry data are unavailable for the second half of 1990, the period immediately following currency union and formal reunification. These six months saw the fastest decline in eastern output, as consumers switched to hitherto unavailable western products and demand from the rest of eastern Europe dropped significantly. During these months in 1990 there was as yet little decline in east German employment as state-owned enterprises waiting for privatization hoarded labor on a massive scale. The initial output index in Table 1, while unavoidable in view of the data constraints, is thus misleading without the description of preceding events.

3/ See, for example, Burda and Funke (1993) and Sinn and Sinn (1993).

Table 1. Descriptive Statistics--East Germany

(Aggregate Manufacturing 1991:1 - 1993:4)

| Period | L | $L_S/L$ | $L_{SS}/L$ | $L_{US}/L$ | $W_S$ | $W_{SS}$ | $W_{US}$ | Q | P |
|---|---|---|---|---|---|---|---|---|---|
| 1991:1 | 1287539 | 53.7 | 37.1 | 9.3 | 8.74 | 8.03 | 7.19 | 100.0 | 100.0 |
| 1991:2 | 1248272 | 55.1 | 36.6 | 8.4 | 9.86 | 8.68 | 8.01 | 86.8 | 99.5 |
| 1991:3 | 1026539 | 54.7 | 36.8 | 8.5 | 10.20 | 8.95 | 8.19 | 92.0 | 99.2 |
| 1991:4 | 894227 | 56.0 | 36.0 | 8.1 | 10.56 | 9.26 | 8.43 | 96.4 | 99.2 |
| 1992:1 | 655767 | 56.7 | 34.9 | 8.3 | 11.10 | 9.84 | 9.10 | 86.9 | 99.2 |
| 1992:2 | 603740 | 58.5 | 34.6 | 6.9 | 12.43 | 10.88 | 9.95 | 87.5 | 99.7 |
| 1992:3 | 554306 | 59.8 | 33.2 | 7.0 | 12.72 | 11.09 | 10.04 | 86.0 | 99.7 |
| 1992:4 | 527492 | 55.0 | 36.6 | 8.4 | 13.25 | 11.80 | 10.69 | 98.9 | 99.5 |
| 1993:1 | 483568 | 56.1 | 35.9 | 8.0 | 13.48 | 12.03 | 10.96 | 77.7 | 99.5 |
| 1993:2 | 472178 | 55.3 | 36.4 | 8.3 | 14.66 | 12.68 | 11.45 | 93.0 | 99.8 |
| 1993:3 | 462488 | 56.6 | 35.1 | 8.2 | 14.92 | 13.07 | 11.85 | 97.9 | 100.0 |
| 1994:4 | 450954 | 57.1 | 34.7 | 8.1 | 15.52 | 13.43 | 12.13 | 106.3 | 99.7 |

Notes: L = number of blue-collar workers in manufacturing; $L_S/L$ = percent of skilled workers; $L_{SS}/L$ = percent of semiskilled workers; $L_{US}/L$ = percent of unskilled workers; $W_S$ = hourly wages of skilled workers; $W_{SS}$ = hourly wages of semiskilled workers; $W_{US}$ = hourly wages of unskilled workers; Q = volume of net output (index 1991:1 = 100); P = producer prices manufacturing (index, 1991:1 = 100).

Table 2. Descriptive Statistics--West Germany

(Aggregate Manufacturing 1991:1 - 1993:4)

| Period | L | $L_S/L$ | $L_{SS}/L$ | $L_{US}/L$ | $W_S$ | $W_{SS}$ | $W_{US}$ | Q | P |
|---|---|---|---|---|---|---|---|---|---|
| 1991:1 | 4932366 | 45.1 | 35.7 | 19.1 | 22.80 | 19.57 | 16.84 | 100.0 | 100.0 |
| 1991:2 | 4941947 | 45.5 | 35.6 | 18.9 | 23.00 | 19.73 | 17.07 | 107.2 | 100.0 |
| 1991:3 | 4986878 | 45.4 | 35.7 | 18.8 | 23.92 | 20.43 | 17.68 | 102.1 | 100.9 |
| 1991:4 | 4938730 | 45.4 | 35.8 | 18.8 | 24.13 | 20.63 | 17.87 | 110.9 | 101.3 |
| 1992:1 | 4855423 | 45.5 | 36.0 | 18.5 | 24.17 | 20.71 | 17.81 | 99.4 | 101.2 |
| 1992:2 | 4808754 | 45.8 | 35.8 | 18.4 | 24.41 | 20.94 | 18.02 | 103.3 | 102.2 |
| 1992:3 | 4800649 | 45.9 | 35.8 | 18.3 | 25.26 | 21.45 | 18.58 | 99.30 | 102.5 |
| 1992:4 | 4696913 | 46.2 | 35.8 | 18.1 | 25.42 | 21.67 | 18.67 | 107.0 | 102.3 |
| 1993:1 | 4505714 | 47.1 | 35.5 | 17.4 | 25.53 | 21.75 | 18.74 | 83.9 | 102.4 |
| 1993:2 | 4397001 | 48.6 | 34.9 | 16.5 | 26.21 | 22.32 | 19.18 | 92.9 | 102.4 |
| 1993:3 | 4324489 | 48.8 | 34.8 | 16.4 | 26.35 | 22.52 | 19.32 | 88.0 | 102.3 |
| 1993:4 | 4367482 | 49.1 | 34.6 | 16.3 | 26.55 | 22.68 | 19.39 | 98.7 | 101.9 |

Notes: See Table 1.

Figure 1. Blue-Collar Employees--Eastern Germany

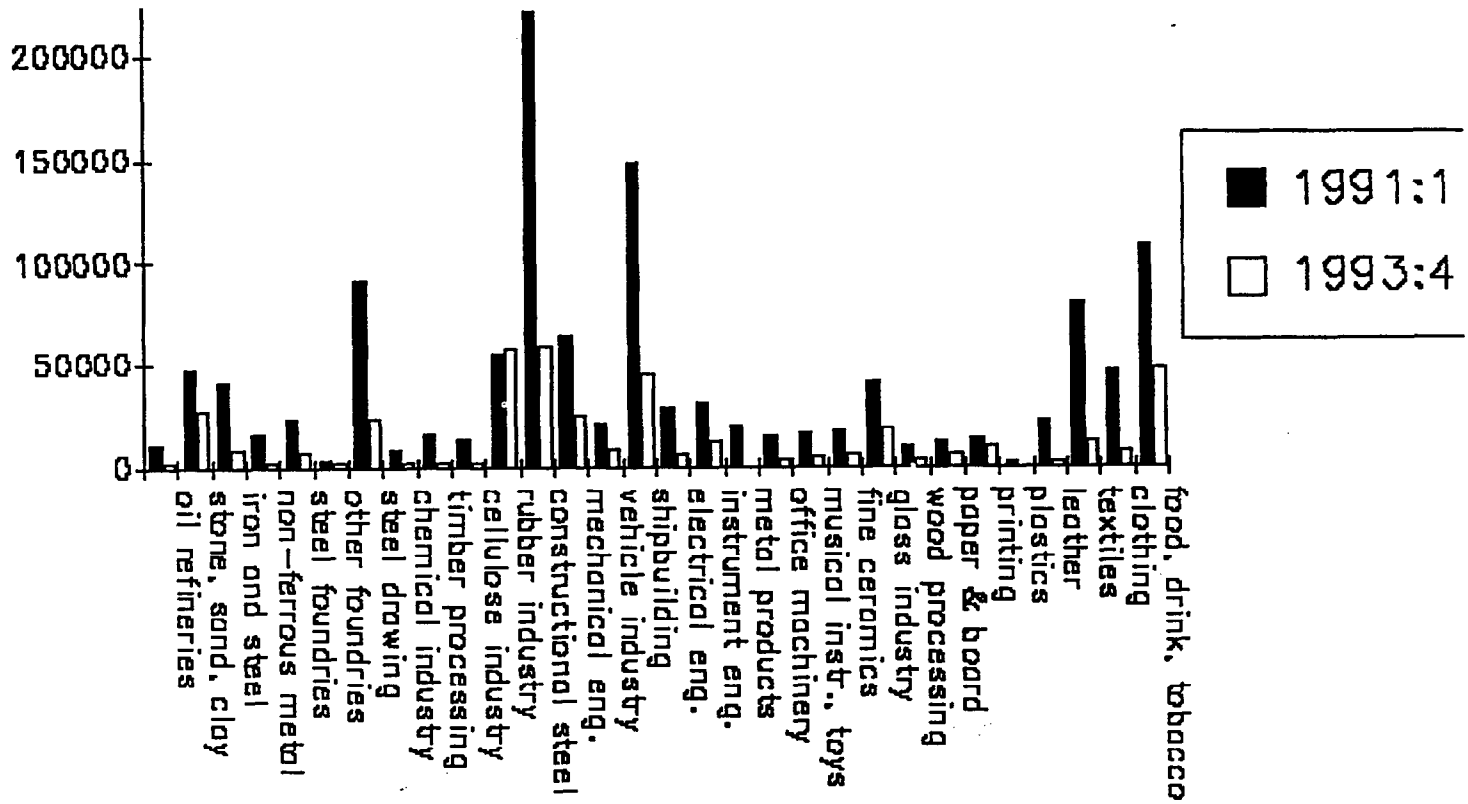
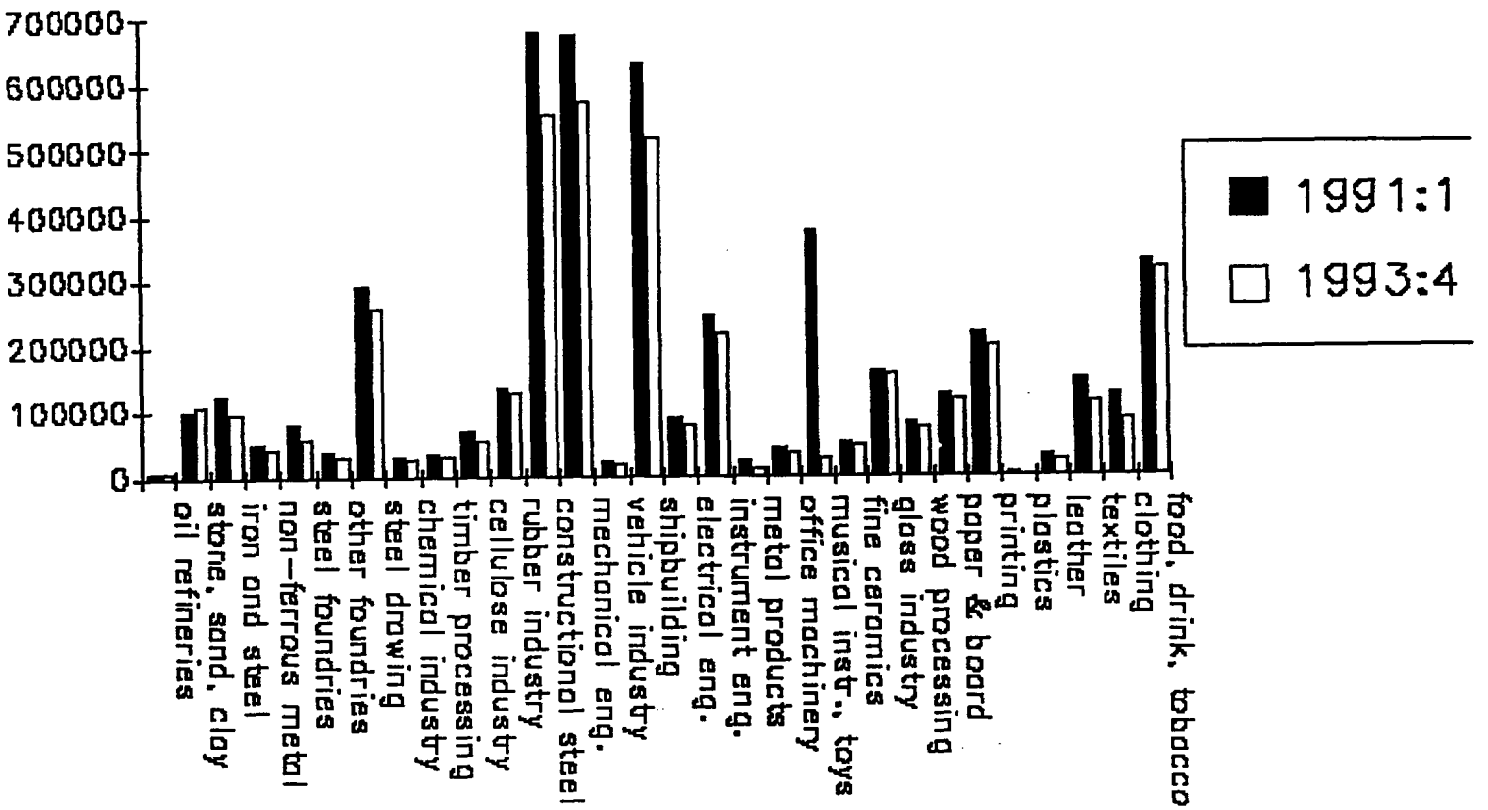


Figure 2. Blue-Collar Employees--Western Germany



west Grman bargainers could expect higher wages and costs in the east to reduce the competitive pressures on their own constituents that would otherwise have come from cheaper eastern products, had wage costs remained low there. Finally, state owned enterprises and their representatives had little incentive to resist wage demands that would be borne by the Treuhand and its successors after privatization.

Lawrence and Lawrence (1985) have proposed an "end-game" model in which permanently declining demand for an industry product, such as steel in the United States in the 1970s, may reduce the wage-employment elasticity. 1/ The simplest version of this model assumes that installed capital is fixed, or immobile, and that investment has become unprofitable at existing wages, due to the expected fall in demand. Output is proportional to labor input, say $Q = L$, and there are no *ex post* substitution possibilities (putty-clay technology). The non-wage variable unit cost is c, and the unit labor cost is w, so if the given industry price, p, exceeds variable unit costs, $p > c + w$, then the firm will continue to satisfy current demand. A higher wage, say $w' > w$, that still satisfies the above inequality (so that $p > c + w'$) will simply transfer quasi-rents from the firm to labor, with no decline in current labor demand. More realistically, costs $c_i$ will vary across firms $i = 1, 2, \ldots$, and a wage increase may cause the highest cost producers to close down. However, the drop in labor demand will still be less than if capital were mobile. Whatever the particular model of wage setting or union bargaining that is envisaged, the combination of declining demand and some form of capital immobility can quite plausibly lead to higher wages and a transfer of quasi-rent as labor demand elasticities fall.

The relevance of this model to east Germany can be questioned however. As plant closure accelerates towards the end of the "end game," wage moderation to save jobs is the likely outcome in conventional bargaining models. The relevance of the "end game" for east Germany is further called into question by the backlog of hoarded labor at the start of the sample period. This suggests that the elasticity of labor demand might well be higher than in west Germany during this time span, rather than lower as claimed by union representatives and as suggested by part of the "end game." In any case, this hypothesis can be directly tested with our data.

A further hypothesis that can be tested with our data is based on capital-skill complementarity. If the elasticity of substitution between capital and unskilled labor is greater than between capital and skilled labor, then the wage-employment elasticity of the unskilled should exceed that for skilled employment. This relationship can be tested for both east and west Germany.

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1/ Lawrence and Lawrence (1985) use this model to explain rising relative wages in U.S. "sunset" industries.

## III. The Wage-Employment-Output Relationship

Those interested in estimating labor demand curves are faced with a rich menu of alternative specifications. The model we outline is based on a representative firm minimizing the labor cost of achieving some given level of output subject to a production function constraint and adjustment costs in altering employment levels. To focus on the dynamic relationship between wages, employment and output, we abstract from movements in other factors of productions such as capital and intermediate goods, and the possibility of factor substitution due to changing relative prices. As this optimization problem has been considered by a number of authors, our discussion can be fairly brief. 1/ We define a restricted cost function which specifies the minimum expenditure to produce some level of output, which for simplicity we take to be

$$C_t = w_t F(L_t, Q_t) \tag{1}$$

where $F(\cdot)$ has the quadratic form

$$F(\cdot) = \alpha_0 + \alpha_1 L_t + \alpha_2 L_t^2 + \alpha_3 Q_t + \alpha_4 Q_1^2 + \alpha_5 L_t Q_t \tag{2}$$

Here $L_t$ is employment, $Q_t$ is output and $w_t$ is the wage rate. The firm's optimization problem may then be written in discrete time as

$$\underset{L_t}{Min} \sum_{t=T}^{\infty} \beta^{1-T}[C_t + W_t G(\cdot)], \tag{3}$$

where $\beta$ is the discount factor, adjustment costs are assumed to be proportional to the wage rate and the adjustment cost function $G(\cdot)$ has the quadratic form

$$G(\cdot) = b_o + b_1 \Delta L_t + b_2 (\Delta L_t)^2 \tag{4}$$

As detailed in Tinsley (1971), the solution to this problem in terms of a cost-minimizing optimal labor input at time T is of the form

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1/ See Tinsley (1971), for example. It is also worth noting that a static multifactor CES production function generates factor demands that depend only on own prices and output. Estimates of different labor components by Bresson *et al.* (1992) yield insignificant coefficients for relative wage variables, so their omission here may not be serious.

$$L_T = \alpha L_{T-1} + \gamma \sum_{t=T}^{\infty} (\alpha\beta)^{t-T} Q_t^E + \delta \sum_{t=T}^{\infty} (\alpha\beta)^{t-T} w_t^E, \quad (5)$$

where $0 < \alpha < 1$ and $\gamma$ and $\delta$ are constants. As expected, intertemporal considerations deriving from the paths of expected wages ($w_t^E$) and expected output ($Q_t^E$) will play an important role in determining the path of equilibrium employment over time in equation (5). Assume that wage and output expectations are generated by an autoregressive process. 1/ By successive substitution this allows us to replace future output and future wages by current and lagged output and wages. Thus the model gives a labor demand function of the form

$$L_t = c + \alpha L_{t-1} + \sum_{i=o}^{m} \phi_i Q_{t-i} + \sum_{i=o}^{m} \theta_i w_{t-i} + \epsilon_t,$$

where $\epsilon_t$ is a random disturbance term. Equation (6) is the estimating equation used in this study. Note that this widely used specification does not depend on any assumptions of perfect competition, and may be regarded as an approximation to the more general case of nonquadratic production functions.

## IV. Panel Data Estimation Issues and Results

The labor demand function to be estimated is the log-linear approximation to the general form:

$$\ln L_{it} = a_o + a_1 \ln L_{i,t-1} + \beta'(L) \ln X_{i,t} + \epsilon_{it} \quad (7)$$

where $i = 1, 2, \ldots, N$ refers to the cross-sectional unit, $t = 1, 2, \ldots, T$ refers to a given time period, $X_{it}$ is the vector of explanatory variables and $\beta(L)$ is the vector of associated polynomials in the lag operator. Thus $L_{it}$ ($L_{i,\,t-1}$) is employment for unit i at time t (t-1). Estimation of dynamic panel data models is a problem frequently encountered in economics. 2/ We use the generalized method of moments estimator (GMM) developed by Arellano and Bond (1991). 3/ This is an efficient extension of the Anderson and Hsiao (1981, 1982) instrumental variables estimator and involves use of all

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1/ A forward looking rational expectations model of labor demand in west German manufacturing has been estimated in Funke (1993).

2/ Compare Matyas and Sevestre (1992) (eds.), pp. 95-117.

3/ An introduction to GMM estimation is available in Greene (1993).

available lags of the regressors from period t-2 and earlier as instruments in a first difference model. 1/

Applying this procedure we begin with a generalized version of equation (7) and estimate it in first differences. All variables are assumed to be endogenous and have to be suitably instrumented. Clearly, the validity of the selected instruments and the GMM estimator relies on the absence of serial correlation in the error term of the untransformed levels model. We test for the absence of this serial correlation using a N(0,1) statistic. Wald statistics and the Sargan statistic provide additional tests of the robustness of our estimates. 2/ In order to take account of structural differences between east and west Germany and of various skill levels, we have estimated separate labor demand equations for the two regions and three skill categories. 3/ Using a traditional general-to-specific approach, we started from a very general lag structure and gradually restricted it until a parsimonious formulation consistent with the data generating process in east and west Germany were obtained. The results of this exercise are presented in Tables 3 and 4, respectively. 4/

The overall results are quite good. The reader can verify that lagged employment has a strong, positive, and significant effect on current employment, indicating the presence of adjustment costs and persistence effects. The coefficient on contemporaneous value added is also positive and significant, as expected. Contrary to the standard theory presented above, however, the own price (the real product wage) has starkly different effects on employment depending on the skill level. The real wage elasticities for skilled and semiskilled blue collar workers are negative

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1/ Arellano and Bond (1991) suggest a two-step procedure for the case where the residuals are heteroscedastic. A disadvantage of the two-step estimator, however, is that the standard errors are biased downwards and should therefore be treated with caution. Nothing can be said about the relative performance of the Arellano and Bond (1991) estimators and the one proposed by Anderson and Hsiao (1982), since the set of instruments is not the same. Simulation studies have shown, however, that the Anderson and Hsiao estimator often leads to rather imprecise estimates (see Arellano and Bond (1991)).

2/ The Sargan test statistics are not robust to heteroscedasticity and therefore tend to reject the null hypothesis too often. A full discussion of the test appears in Arellano and Bond (1991).

3/ All of the variables and their sources are briefly explained in the Appendix.

4/ The data range from 1991:1-1993:4. Note, however, that observations are retained for the first difference transformations as well as for the creation of lags. For lack of data, we have not considered the capital stock as an additional regressor. The absence of capital stock data is unlikely to pose a serious problem. In similar panel estimates of labor demand in former West Germany capital stock elasticities were found to be very small compared to elasticities for our present set of variables (FitzRoy and Funke (1994)).

Table 3. Labor Demand Equations for Skilled, Semiskilled and Unskilled Blue Collar Workers in East German Manufacturing

(Panel Dataset of 30 Manufacturing Industries, N = 270)

| Independent Variables | Skilled Workers ($L_S$) | Semiskilled Workers ($L_{SS}$) | Unskilled Workers ($L_{US}$) |
|---|---|---|---|
| Constant | -0.01<br>(0.2) | 0.02<br>(0.4) | 0.13<br>(1.0) |
| $L_{S,t-1}$ | 0.75<br>(7.5) | -- | -- |
| $L_{SS,t-1}$ | -- | 0.76<br>(11.7) | -- |
| $L_{US,t-1}$ | -- | -- | 0.57<br>(5.5) |
| $Q_t$ | 0.24<br>(2.8) | 0.20<br>(2.9) | 0.39<br>(1.6) |
| $(W/P)_{S,t-2}$ | -0.15<br>(0.5) | -- | -- |
| $(W/P)_{SS,t-2}$ | -- | -0.14<br>(0.5) | -- |
| $(W/P)_{US,t-2}$ | -- | -- | -1.21<br>(2.2) |
| Diagnostics | | | |
| RSS | 9.64 | 13.48 | 10.12 |
| TSS | 7.50 | 11.58 | 6.96 |
| SC(1) | -2.98 | -3.30 | -2.76 |
| SC(2) | 1.30 | 0.40 | 1.96 |
| SARGAN | 52.89 (63) | 32.73 (63) | 66.87 (63) |
| WALD | 33.71 (9) | 50.07 (9) | 24.05 (9) |

Notes: All variables are logged and the equations are estimated in first differences using the GMM estimator; t-statistics based on White's (1980) consistent corrections for heteroscedasticity are given in parentheses. Time dummies are included but not reported. $SC_1$ ($SC_2$) is a test for first-order (second-order) serial correlation in the residuals. Both tests are asymptotically distributed as standard normal N(0,1) under the null of zero serial correlation. WALD is a test of the joint significance of the time dummies, asymptotically distributed as $X^2$ (degrees of freedom in parentheses) under the null of no relationship. The instrument validity (SARGAN) test statistic is a $X^2$ test of over-identifying restrictions (degrees of freedom in parentheses) under the null of instrument validity.

Table 4. Labor Demand Equations for Skilled, Semiskilled and Unskilled Blue Collar Workers in West German Manufacturing

(Panel Dataset of 30 Manufacturing Industries, N = 270)

| Independent Variables | Skilled Workers ($L_S$) | Semiskilled Workers ($L_{SS}$) | Unskilled Workers ($L_{US}$) |
|---|---|---|---|
| Constant | -0.06<br>(1.9) | -0.07<br>(2.3) | 0.06<br>(2.4) |
| $L_{S,t-1}$ | 0.30<br>(1.8) | - | - |
| $L_{SS,t-1}$ | - | 0.36<br>(2.3) | - |
| $L_{US,t-1}$ | - | - | 0.72<br>(5.3) |
| $Q_t$ | 0.26<br>(3.6) | 0.34<br>(2.7) | 0.16<br>(2.2) |
| $(W/P)_{S,t-2}$ | -0.14<br>(1.3) | - | - |
| $(W/P)_{SS,t-2}$ | - | -0.24<br>(1.8) | - |
| $(W/P)_{US,t-2}$ | - | - | -0.41<br>(3.2) |
| Diagnostics | | | |
| RSS | 1.55 | 2.53 | 3.85 |
| TSS | 1.15 | 1.54 | 2.64 |
| SC(1) | -1.59 | -2.69 | -1.73 |
| SC(2) | 0.78 | 1.70 | 0.30 |
| SARGAN | 42.71 (63) | 38.73 (63) | 40.92 (63) |
| WALD | 22.63 (9) | 28.04 (9) | 27.48 (9) |

Notes: See Table 3.

but not significantly different from zero, while the real product wage elasticities for unskilled workers are highly significant in both parts of Germany. 1/ In other words, the picture that emerges from these results is that in the 1991 to 1993 period employment of unskilled workers was much more sensitive to wage increases than that of semiskilled and skilled production workers. 2/

The validity of the specification is verified in a number of ways. The N(0,1) tests indicate that first-order serial correlation is significant while second-order serial correlation is insignificant. This confirms the absence of serial correlation in the untransformed levels model. 3/ The Wald tests indicate joint significance of selected regressors as well as of time dummies. The Sargan test confirms the validity of instruments used.

The results in Table 5 are suggestive of regional differences in the responsiveness of labor demand to real product wages. The absolute values of the real wage elasticities are generally higher in east Germany than in west Germany. 4/

Particularly for unskilled workers, the elasticities are precisely determined, and their much greater (absolute) values in east Germany clearly contradict union claims about the unresponsiveness of employment there. Taken at face value, the results also appear to reject the "end-game" hypothesis. However, the initial condition of extensive labor hoarding is likely to overwhelm any "end-game" effect of capital immobility, so final judgement on this issue must be deferred. Initial labor hoarding is the most plausible explanation for the more elastic Eastern responses. These may thus not be generally valid in the future, and "equilibrium" western responses may be more appropriate for the purpose of forecasting and policy prediction.

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1/ The insignificant real wage effects on labor demand for skilled and semiskilled workers in east Germany lend support to the cross-section results presented in Burda and Funke (1993).

2/ It may be argued that unskilled workers can more easily be replaced by machinery, whereas semiskilled and skilled labor is needed to operate and maintain the machinery.

3/ If the lagged dependent variable is excluded from the model, then we find serial correlation problems.

4/ This result confirms Tooze's (1976) empirical results for the U.K. One explanation for the differing wage elasticities is that German manufacturing industries reveal a positive effect of capital intensity on the skill ratio, implying a greater elasticity of substitution between capital and unskilled labor than between capital and skilled labor. Empirical evidence for this capital-skill complementarity hypothesis is available in FitzRoy and Funke (1992). While capital intensity was certainly much lower in east Germany, the presence of large scale labor hoarding at the start of the sample period means that we cannot identify the source of the regional elasticity disparity with much confidence, or even reject the "end-game" interpretation.

Table 5. Estimated Short-Run and Long-Run Wage Elasticities of Labor Demand by Skill Level and Area

| | Skilled Workers | Semiskilled Workers | Unskilled Workers |
|---|---|---|---|
| Eastern Germany | | | |
| Short-run elasticities | -0.15 | -0.14 | -1.21 |
| Long-run elasticities | -0.60 | -0.58 | -2.81 |
| Western Germany | | | |
| Short-run elasticities | -0.14 | -0.24 | -0.41 |
| Long-run elasticities | -0.20 | -0.37 | -1.46 |

## V. Conclusions

The purpose of this paper has been modest--to inquire into the determinants of labor demand in east and west Germany over the period 1991:1 to 1993:4. The results support the existence of complementarities between capital and skill, so that unskilled labor demand is much more responsive to wage changes. Contrary to claims by union leaders and some academics, eastern labor was in general more responsive to wage increases, probably due to the large amount of hoarded labor still held at the start of the sample period.

These results underline the vulnerability of unskilled labor in developed economies, both to technical change and to competition from cheap labor in the developing countries, now including eastern Europe. They also help to explain some of the major differences between the United States and European labor market experience found by Freeman (1994) and others. In the U.S. declining real wages for the lowest paid unskilled workers have contributed to higher-than-European labor market participation rates, and lower short-term unemployment since 1980. In Europe (excluding the United Kingdom), centralized corporatist bargaining has generated high real wage growth for a declining proportion of the labor force, though without the increasing wage inequality that affects the United States. High European unemployment is mainly concentrated among the unskilled, is of longer duration, and is exacerbated by a growing number of discouraged workers who have withdrawn from the labor market and are no longer seeking employment.

Recent research reveals that much of the difference in recorded unemployment rates between east and west Germany is due to discouraged workers in the west. 1/ Labor force participation in both parts of Germany is approximately equal at 65 percent, compared to 70 percent in the United States where working hours are also greater. At the same time American men in the bottom decile of the distribution earn less than half the real wage of the poorest German decile. 2/

These results complement our own and reveal the high price paid in terms of nonemployment by high wage countries such as Germany, for their relatively egalitarian wage structure. Collective bargainers and policy makers in Germany therefore clearly need to pay more attention to the unpleasant facts relating wages, skills, and employment. 3/

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1/ Compare Der Spiegel, No. 49, November 14, 1994, p. 123.

2/ Freeman (1994), p. 13.

3/ Moderate recent wage settlements, stagnating real wages, and rapid productivity growth have helped to bring Germany out of recession more rapidly than expected. However, union are already aiming at making up for lost ground with substantial increases in the next bargaining round.

## Data Sources and Definitions

The following data appendix describes noteworthy methodological or definitional aspects of the data and variables.

### 1. Sample

We use the most disaggregated available data on various wage and employment categories for west German industries. The principal data sources are Statistisches Bundesamt, Fachserie 16, Reihe 2.1., Fachserie 4, Reihe 4.1.1. and 4.1.2. and Fachserie 17, various years. The Central Statistical Office (Statistisches Bundesamt) provides quarterly (January, April, July and October) wage, and employment data by skill level and industry for blue-collar workers as well as sector-consistent net output (value added) and producer price data by industry. We have used a sample of 30 two-digit manufacturing industries with continuous observations from 1991:1-1993:4. The industries covered are:

a. Definition of manufacturing industries:

(1) Oil refineries
(2) Stone, sand, clay and asbestos industry
(3) Iron and steel industry
(4) Non-ferrous metal industry
(5) Iron and steel foundries
(6) Non-ferrous metal foundries
(7) Steel drawing and cold rolling mills
(8) Chemical industry
(9) Sawmills and timber processing
(10) Cellulose, paper, and board industry
(11) Rubber industry
(12) Constructional steel
(13) Mechanical Engineering
(14) Vehicle building industry (including repair of vehicles)
(15) Shipbuilding
(16) Electrical engineering
(17) Instrument engineering
(18) Metal products
(19) Office and data-processing machines
(20) Musical instruments, toys, and jewellery
(21) Fine ceramics
(22) Glass industry
(23) Wood processing
(24) Paper and board
(25) Printing
(26) Plastics manufacturing
(27) Leather
(28) Textiles
(29) Clothing
(30) Food, drink, and tobacco

b. Variables

$L_i$: Number of blue-collar workers of skill level i = S, SS, US. The official classification lists 3 groups of blue collar workers, two of which require formal training and/or experience. Skilled blue collars ($L_S$) must have completed at least a 3-year apprenticeship. $L_S$ include workers up through the foreman level, but exclude supervisory personnel beyond the foreman level. Semiskilled workers ($L_{SS}$) have received on-the-job training of at least one year. All remaining production workers, classified as unskilled workers ($L_{US}$), perform routine, simple tasks without professional training.

$w_i$: Hourly wages of blue-collar workers of skill-level i = S, SS, US (workers' compensation includes employers' contributions to social insurance, pensions, medical insurance, and other benefits).

$Q_i$: Volume of net output (gross value added) of industry i (index, 1991 = 100).

$P_i$: Producer prices of industry i (index, 1990 = 100).

## References

Anderson, T.W. and C. Hsiao, "Estimation of Dynamic Models Using Panel Data," *Journal of the American Statistical Association*, Vol. 76 (1981), pp. 598-606.

_____, and _____, "Formulation and Estimation of Dynamic Models Using Panel Data," *Journal of Econometrics*, Vol. 18 (1982), pp. 47-82.

Arellano, M. and S. Bond "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations," *Review of Economic Studies*, Vol. 58 (1991), pp. 277-97.

Bresson, G., F. Kramarz, P. Sevestre "Heterogeneous Labor and the Dynamics of Aggregate Labor Demand," *Empirical Economics*, No. 17 (1992), pp. 53-168.

Burda, M. and M. Funke, "German Trade Unions after Unification--Third Degree Wage Discriminating Monopolists," *Weltwirtschaftliches Archiv*, No. 129 (1993), pp, 537-60.

FitzRoy, F. and M. Funke, "Capital-Skill Complementarity and Relative Employment in West German Manufacturing," London Business School, Centre for Economic Forecasting, Discussion Paper No. 16-92 (1992).

_____, and _____, "Real Wages, Investment and Employment: New Evidence from West German Sectoral Data," *Weltwirtschaftliches Archiv*, Vol. 130 (1994), pp. 258-72.

Freeman, R. (ed.), *Working Under Different Rules*, Russell Sage Foundation (1994).

Funke, M., "A Rational Expectations Approach to Labor Demand in West German Manufacturing," *Allgemeines Statistisches Archiv*, Vol. 77 (1993), pp. 137-48.

Greene, W.H., *Econometric Analysis* (New York: N.Y., 1993).

Hamermesh (1993) *Labor Demand*, Princeton (Princeton University Press).

Lawrence C. and R.Z. Lawrence "Manufacturing Wage Dispersion: An End-Game Interpretation," *Brookings Papers on Economic Activity*, No. 1 (1985), pp. 47-106.

Matyas, L. and Sevestre, P. (eds.), *The Ecoometrics of Panel Data. Handbook of Theory and Applications*, Dordrecht (1992).

Nissim, J., "The Price Responsiveness of the Demand for Labor by Skill: British Mechanical Engineering, 1963-1978," *Economic Journal*, No. 94 (1984), pp. 812-25.

Schulte zur Surlage, R., *Qualifikationsstruktur der Arbeitsnachfrage*, Frankfurt (Campus Verlag, 1985).

Sinn, G. and H.-W. Sinn *Kaltstart*, Munich (1993).

Tinsley, P., "A Variable Adjustment Model of Labor Demand," *International Economic Review*, Vol. 12 (1971), pp. 482-451.

Tooze, M.J., "Regional Elasticities of Substitution in the United Kingdom in 1968," *Urban Studies*, No. 13 (1976), pp. 35-44.

White, H., "A Heteroscedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroscedasticity," *Econometrica*, No. 48 (1980), pp. 817-38.