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## Industrial change, stability of relative earnings, and substitution of unskilled labor in West-Germany

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Discussion Paper No. 98–22

**Industrial Change, Stability of Relative  
Earnings, and Substitution of Unskilled Labor  
in West Germany**

**Viktor Steiner  
Robert Mohr**

## 1 Introduction

The differential labor market developments in Germany<sup>1</sup> and in the United States are often cited to support the hypothesis of a trade-off between more jobs for unskilled workers on the one hand, and a less equal earnings distribution on the other. In contrast to the United States, unemployment of unskilled German workers increased substantially since the early 1980's while the distribution of earnings changed little (see, e.g., Gottschalk and Smeeding 1997, Steiner and Wagner 1998). Given that the German economy is affected by technological change and international competition to a similar extent as the U.S. economy, these differential labor market developments are usually explained by the much greater importance of institutional factors in Germany which are hypothesized to lead to a rigid wage structure. These factors include effective wage floors set by collective bargaining agreements, unions' "solidaristic wage policy" aiming at uniform relative wage increases, and income support schemes characterized by high earnings replacement ratios (see, e.g., Abraham and Houseman 1995, Siebert 1997). However, not all observers seem convinced that these factors have contributed significantly to the high unemployment rates of unskilled workers in Europe, and in Germany in particular (see, e.g., Nickell 1997 for a pessimistic view).

Although the relationship between (changes in) the employment of unskilled workers and relative wages has been analyzed in a number of empirical studies, no consensus view seems to have emerged so far. For a small cross-section of developed market economies, OECD (1996) reports a significant positive relationship between unemployment rates and a measure of earnings inequality; this correlation disappears, however, when first differences of unemployment rates rather than their levels are considered. In a study covering a larger number of countries, Blau and Kahn (1996) find that employment ratios of low-skilled workers are lower in countries with a more compressed earnings distribution than in the U.S., but this correlation, too, seems far from conclusive, to say the least. After comparing the development of relative unemployment rates and wages for various skill groups in a number of OECD countries, Nickell and Bell (1995: 46) conclude that "there seems to be no evidence that the unemployment rate effects are any more severe in countries where the wage effects are small". On the basis of a comparative study including the U.S., Canada and France, Card, Kramarz and Lemieux (1996) find little evidence for the hypothesis that the more compressed earnings distribution in France, which hardly changed during the observation period, generated significantly different employment trends than in the other two countries characterized by a higher degree of wage flexibility.

On the basis of a similar methodology as employed by these authors, Krueger and Pischke (1997) and Beissinger and Möller (1998) find for Germany that there is no

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<sup>1</sup> Here and in the following, Germany always refers to West Germany prior to unification.

significant correlation between the change in the employment-to-population ratio disaggregated by age-education cells and the respective wage in the base period. Other studies for Germany, which rely on the estimation of standard partial-equilibrium labor demand models, tend to find a significant negative relationship between the relative employment of unskilled labor and relative wages.<sup>2</sup> However, estimated substitution elasticities between unskilled and skilled labor vary a great deal between the various studies, depending on the economic sector analyzed, the time period, the way skills are measured and the specification of the production technology. The same is also true regarding the estimated effects of skill-biased technological change on the relative demand for labor.

This paper builds on and extends previous work for Germany by Steiner and Wagner (1997) who find a rather low substitution elasticity between unskilled and skilled male labor for the whole manufacturing sector of about  $-0.3$  and a trend decline in the skills ratio of about 3% per year. Given these estimates, the authors conclude that even reductions in the relative earnings of unskilled workers on a scale observed for the U.S. labor market would not have been sufficient to bring employment of unskilled workers in West German manufacturing back to previous levels. In this paper, we extend their analysis for the manufacturing sector to the whole German economy and analyze the economic factors which have contributed to the dramatic decline of the employment share of unskilled labor in German manufacturing, in particular the role played by the relatively rigid earnings structure. In the next section, we present some stylized facts on relative earnings and employment trends in the German economy since the mid-1970's. The econometric model of substitution between unskilled and skilled labor and its relation to the development of relative earnings is set out in section 3. Estimation results are presented and discussed in section 4, and section 5 concludes.

## **2 Some Stylized Facts**

To set the scene for the following empirical analysis, we first present some stylized facts on employment and earnings trends in West Germany. To begin with, we first describe general trends referring to the whole economy before sectoral evidence is presented for the period 1975 to 1990, for which individual-level earnings information differentiated by skills is available. Then we look at the development of relative employment and earnings at a more disaggregated level.

Between the recession year 1975 and the pre-unification year 1990, overall employment in West Germany increased by almost 14% from 22,4 to 25,5 millions, where the strongest increase occurred in the second half of the eighties when about

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<sup>2</sup> For econometric studies on substitution elasticities in Germany see, e.g., Fitzroy and Funke (1995), Entorf (1996), Falk and Koebel (1997a, 1997b), Fitzenberger and Franz (1997), Steiner and Wagner (1997), and Beissinger and Moeller (1998).

2 million jobs net were created. Since labor supply increased strongly throughout the period, even the relatively strong employment increase in the second half of the eighties was insufficient to bring down overall unemployment to its level before the recession of the early eighties. In 1990, the unemployment rate as measured by the OECD stood at 6%, compared with a level of 4% in the recession year 1975.

The increase of unemployment in the 1980's mainly occurred among the unskilled and older male workers. The strong increase in female labor supply did not result in higher unemployment of women, but in an increasing share of female employment throughout the period. In the high-growth period in the second half of the 1980's alone, the share of females in employment increased by 5 percentage points.<sup>3</sup> This increase was related to changes in educational attainment of females, the expansion of the service sector and the extension of female part-time work. Between 1985 and 1990 the service sector expanded by more than 2 million employees, while the share of females in this sector increased from about 55 to 60 percent. The share of part-time employed among all female employees increased by about 5 percentage points to 36 percent in this period, where part-time employment is concentrated in services and the public sector.

In the period from the mid-1970's to the end of the 1980's, employment of unskilled workers in the whole West German economy dropped by almost 36%, while the number of skilled employees increased by 30%. Employment losses for the unskilled in manufacturing were markedly higher than in the service sector, but even there employment of this group dropped by more than 20%. Within the manufacturing sector, these employment losses ranged from 35% in industries producing investment goods to almost 50% in mining and energy production (see Sachverständigenrat 1994, Table 51).<sup>4</sup>

To what extent have demand and supply factors contributed to these employment trends? Based on a shift-share analysis, Abraham and Houseman (1995) try to attribute the change in the relative demand for workers of different skill groups to changes in the sectoral composition of employment. They conclude that, due to shifts in the sectoral distribution of employment, the demand for unskilled workers markedly decreased, while the demand for workers with an occupational qualification increased substantially in the 1970's. According to their calculations, the demand for skilled labor kept on increasing in the 1980's at roughly the same pace as in the previous period, while the demand for unskilled labor stagnated. On the supply side, the share of the population aged between 20 and 60 years with an occupational qualification (apprenticeship training and technical school degrees)

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<sup>3</sup> These and, if not otherwise stated, the following facts are documented in Steiner and Wagner (1997).

<sup>4</sup> While the stronger growth in service sector employment is usually stressed as the main factor for the better employment performance of the U.S. economy relative to Germany, the fact that manufacturing employment in Germany declined markedly while it remained more or less constant in the U.S. is usually overlooked (see Schimmelpfennig 1997).

increased from 55% in the mid-seventies to about 63% at the end of the eighties, while the percentage of unskilled people decreased from about 40% to about 28% of the population (Abraham and Houseman, 1995, Table 11.10).<sup>5</sup>

In the light of the general labor market developments described above, the German unemployment problem seems to be closely related to the employment decline of unskilled workers, especially in the manufacturing sector. In the following, we present some sectoral evidence on the development of skill-specific trends in employment and earnings in the period 1975 to 1990. The data set used here and also for the subsequent regression analyses derives from merging data from the disaggregated national accounts for two-digit manufacturing industries and individual-level employment and earnings information from social security records for the period 1975 to 1990 (see the data appendix). The main advantage of the social security data for the present purpose is that it allows us to calculate employment shares and earnings ratios for meaningfully defined skill groups and also by labor market experience.<sup>6</sup>

As in Steiner and Wagner (1997), we define workers as *unskilled* if they neither have obtained a vocational qualification (apprenticeship) nor a degree in higher education. Workers with a vocational degree and/or university entry level degree are classified as *skilled* and distinguished from those employees with a degree from an university or polytechnical school (*Fachhochschule*) who are called *graduates*. While the number of skilled male workers in manufacturing slightly increased after the recession in the mid-seventies and then remained fairly constant, employment of unskilled labor decreased and of graduates increased throughout the whole period. The employment decline of the unskilled also seems to have accelerated in the eighties, while the growth in employment of graduates was particularly strong in the second half of the decade. Nevertheless, it seems unlikely that graduates have been substituted for unskilled labor, and our interest in the following will focus on the development of the ratio of unskilled workers to skilled workers, the skills ratio for short.<sup>7</sup> As for relative earnings, we use median rather than average earnings here because the latter are affected by the change in the coding of fringe benefits in the social security data in 1983/84 (see Steiner and Wagner 1998).

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<sup>5</sup> The unskilled category also includes those who didn't answer to the questions on educational attainment.

<sup>6</sup> The differentiation between, respectively, production/non-production or blue-/white-collar workers often found in the U.S. literature is, in our opinion, not a useful one, at least for the German situation. Another possible differentiation used in German studies is based on the qualification grouping ("Leistungsgruppen") found in collective bargaining agreements, which differentiates between three blue-collar and four white-collar groups (see, e.g., Entorf, 1996 for a recent study). However, this classification does not differentiate workers by their level of labor market experience.

<sup>7</sup> This is also motivated by the fact that for a very high share of all graduates earnings are censored at the social security threshold (see Steiner and Wagner 1998).

The plots in Figure 1 track the development of employment and earnings growth for unskilled and skilled men and women, respectively. In each case, the analysis is presented for all manufacturing, all services, and the two largest non-manufacturing sectors for each gender. As for the trends in relative employment, the figures show that, for both men and women, the strongest decline in the employment of unskilled workers occurred in the manufacturing sector, and for men also in construction and in transport. Employment of skilled workers in manufacturing increased, where the increase was substantial for females in the second half of the eighties. However, most of the increase in employment of skilled workers occurred in services, where the increase was especially strong for females. In contrast, employment of unskilled workers exhibits a negative trend in all sectors shown.

Relative to the divergence of employment levels there was little change in relative earnings, although the figures show some noteworthy sectoral and gender differences. For males, only the service sector shows some increase in earnings inequality between skilled and unskilled workers. For females, earnings inequality seems to have actually decreased in the whole manufacturing sector and in personal services. Given the strong increase in the employment of skilled relative to unskilled women in personal services, the divergence in earnings implies that the increase in the supply of skilled labor has outpaced its demand.

**Figure 1—Employment and earnings trends of unskilled and skilled workers in West Germany, 1976-1990**

**Figure 1—continued**

To provide a more quantitative assessment of the developments of relative employment and earnings trends we ran regressions of, respectively, the log skills ratio and the log earnings ratio on a linear time trend. Estimation results are summarized in Table 1. The regressions involving the skills ratio reveal the following stylized facts. The skills ratio has decreased in all sectors, for both men and women. In other words, the growth of skilled employment exceeded the growth of unskilled employment in all sectors of the economy within the observation period. This effect was stronger for women than for men in all sectors. In manufacturing the skills ratio decreased on average by a yearly rate of about 3 percent for males and about 5 percent for females. Except for business services, this decline is quite uniform across sectors for men, whereas there are marked differences for females. For them, the strongest decline of the skills ratio occurred in business services with an average yearly rate of more than 6 percent.

**Table 1—Regressions of skills and earnings ratios against trend**

	Males				Females			
	log skills ratio		log earnings ratio		log skills ratio		log earnings ratio	
manufacturing	-.029	(.001)	.001	(.000)	-.050	(.002)	.004	(.000)
construction & transportation	-.030	(.002)	.004	(.001)	-.056	(.003)	-.003	(.001)
wholesale & retail trade	-.026	(.001)	.000	(.000)	-.047	(.002)	.001	(.001)
all services	-.024	(.001)	-.007	(.000)	-.051	(.001)	.001	(.000)
personal service	-.023	(.002)	-.005	(.001)	-.050	(.002)	.005	(.001)
business services	-.048	(.002)	-.007	(.001)	-.062	(.002)	.006	(.001)
public services	-.020	(.001)	-.004	(.000)	-.047	(.001)	.001	(.001)

*Note:* Standard errors are given in parantheses.

*Source:* IABS data, own calculations.

The regression results relating to the log of the earnings ratio reveal that it changed very little in the observation period. This holds for all sectors of the economy and for both men and women. The main gender differences seem to have occurred in the service sector. Whereas unskilled male workers have experiences a small deterioration in their relative earnings position, relative earnings of unskilled females working in the personal and service sectors have even slightly improved. This confirms what is already apparant from Figure 1.

For the 1980's, the overall stability of the earnings distribution has also been confirmed by Steiner and Wagner (1998) who show that the average earnings

differential between skilled and unskilled workers has become even slightly smaller in the observation period. However, as observed by Steiner and Wagner (1997), there are some marked industry differences within the manufacturing sector. Differentiating by import intensity and the rate of technological change (as measured by the growth in total factor productivity), they show that, e.g., in industries with the lowest import share the ratio of unskilled to skilled workers declined by 29.6%, while it dropped by about 40% in the 25% of industries with the highest import shares. On the other hand, the ratio of median earnings increased in industries with relatively low import shares, while unskilled workers in industries more heavily affected by international trade experienced a modest decline in their relative earnings. As for the differential impact of technological change, Steiner and Wagner (1997) show that the relative decline in the sector with the fastest growth rate of total factor productivity was much stronger than in industries which experienced little technological change (41% versus 26%). Relative earnings of unskilled workers in these industries increased somewhat, while they remained fairly constant in those industries where productivity growth increased most in the observation period. Hence, the overall stability of the earnings ratio seems to result to some extent from compensating trends in industries which are differently affected by international competition and technological change.

### **3 Substitution between Unskilled and Skilled Labor**

The effects of demand and supply shocks on the relative employment and earnings position of unskilled workers in the domestic economy can be analyzed on the basis of a straightforward extension of the standard partial-equilibrium labor market model (see, e.g., Bound and Johnson 1992, Katz and Murphy, 1992, Nickell and Bell 1995, 1997). These effects depend on the slope of the relative demand curve for unskilled and skilled labor, that is the substitution elasticity between these two groups, the position and slope of their respective supply curves, and the extent to which trade and technological shocks shift the relative demand curve for labor. A relatively high absolute value of the substitution elasticity between unskilled and skilled labor would indicate that a small change in relative wages has a relatively large impact on relative employment. Under such conditions, a relative supply or demand shock affecting especially unskilled labor could lead to a marked increase in this factor's relative employment in the presence of rigid wages. On the other hand, if the elasticity of substitution is low, then even a large adverse shock would be unlikely to significantly affect relative employment levels. Hence, the size of the substitution elasticity between unskilled and skilled labor is crucial for the evaluation of the hypothesis that, in the presence of non-neutral negative demand shocks, the rigidity of relative wages has caused the decline in the relative employment of unskilled labor.

In their influential studies on the causes for the observed changes in relative wages in the U.S., Bound and Johnson (1992) and Katz and Murphy (1992) derive

substitution elasticities between skilled (college) and unskilled (high school) labor of about -1.7 and -1.4, respectively. For Germany, estimates of this substitution elasticity vary a great deal between the various studies, depending on the economic sector analyzed, the time period, the way skills are measured and the specification of the production technology. For example, on the basis of a linear approximation of a two-level CES production function, Fitzroy and Funke (1995) obtain an average substitution elasticity between blue-collar workers and the capital-white-collar subaggregate of  $-0.5$  for a sample of two-digit manufacturing industries. Using a standard CES specification of the production technology, Entorf (1996) estimates a substitution elasticity between unskilled and skilled blue-collar workers in manufacturing of about  $-1$  and, depending on the specification, between  $-1.5$  and  $-0.5$  for white-collar workers. Also relying on a CES production function, Möller (1996) obtains an average substitution elasticity between unskilled and skilled workers of  $-1.7$  for a subsample of male workers in the manufacturing sector, while Beissinger and Möller (1998) report estimated substitution elasticities ranging between  $-0.4$  and  $-1.7$  for males and  $-2.1$  and  $-3.3$  for females (depending on the time period analyzed). On the basis of a different functional form specification of the production technology Falk and Koebel (1997a) also find a relatively large substitution elasticity between unskilled and skilled labor for the manufacturing sector producing tradeables and somewhat smaller substitution elasticities for several other non-traded goods. However, using disaggregated industry data and a more general specification of the production technology, Falk and Koebel (1997b) find much lower substitution elasticities between unskilled and skilled labor. Using the same data base but a more disaggregated industry classification, Fitzenberger and Franz (1997) find substitution elasticities between unskilled and skilled labor which vary between  $-0.4$  in mechanical engineering and about  $-2.5$  in trade. Here, we extend previous work by Steiner and Wagner (1997) for the manufacturing sector, who found a relatively small substitution elasticity of  $-0.3$ , and analyze the relative employment decline in the whole West German economy, where we also differentiate between men and women. As in most of the studies mentioned above, our working hypothesis will be that the decline in the supply of unskilled labor has affected all analyzed sectors to a similar extent, and that employment is mainly determined by the demand side of the labor market. Given these assumptions, the substitution elasticity between unskilled and skilled labor can be estimated on the basis of the following simple econometric model (see, e.g., Hamermesh 1993, chapter 2, Shadman-Mehta and Sneesens 1995, Goux and Maurin 1997). Assuming that technology can be characterized by a constant-returns-to-scale (CES) cost function and strong separability between these two types of labor and all other

inputs<sup>8</sup>, and assuming that one can aggregate across firms, the total cost functions in period  $t$ ,

$$(1) \quad C_t = \sum_{i,g} c_{i,g,t}$$

can be specified as sum of lower-level CES cost functions of the form

$$(2) \quad c_{i,g,t} = Y_{it} \left[ \lambda_{u,t} \alpha_{ig}^\sigma w_{u,i,g,t}^{1-\sigma} + \lambda_{s,t} \alpha_{ig}^\sigma w_{s,i,g,t}^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$$

$Y$  stands for output,  $\lambda$  is a relative efficiency parameter for each skill group assumed equal across all industries and groups,  $w$  is the wage rate (earnings), and  $\sigma$  is the substitution elasticity between the two types of labor;  $u, s, i, g$  refer to unskilled workers, skilled workers, industry, and experience group, respectively, and  $t$  is a time index measured in years. To take differences in human capital within unskilled and skilled labor into account, following Steiner and Wagner (1997) we have disaggregated these two groups by the level of labor market experience, which is an important factor for both the determination of employment and earnings. In particular, economic change due to increased import competition or technological change should mainly have affected older workers who find it more difficult to adjust than workers with little labor market experience. Furthermore, individual earnings in Germany increase substantially with labor market experience as implied by human-capital theory (see, e.g., Steiner and Wagner, 1998). The disaggregation of the two skill groups by their level of labor market experience is based on the social security data described in the appendix. Given that too fine a disaggregation would leave us with an insufficient number of observations in certain industry×formal skill×experience cells, we use five experience groups, that is less than six years, 6 – 15, 16 – 25, 26 – 35, and more than 36 years of labor market experience.

We use two levels of aggregation of industries. For the analyses covering the whole economy we aggregated manufacturing industries into 5 subsectors, the other industries were aggregated into 18 service industries and one sector covering agriculture and mining (see the appendix). Combined with manufacturing, this produces a disaggregation of the whole economy into 24 industries that, when multiplied by the 5 experience groups and sixteen years of observations, produce a total of 1,920 possible observations (cells). In the estimation, observations referring to cells which contained either no skilled or no unskilled workers are removed from the sample. We will also present results for the manufacturing sector only, which relies on a finer disaggregation into 30 manufacturing industries as used in Steiner and Wagner (1997).

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<sup>8</sup> For the more general case without this strong separability assumption and with four factors of production see Shadma–Mehta and Sneesens (1995).

Given the specification of the cost functions from above, the demand functions for the two types of labor can be derived by applying Shephard's lemma, i.e.:

$$(3) \quad \frac{\partial \bar{c}_{i,g,t}}{\partial w_{u,i,g,t}} = L_{u,i,g,t} = Y_{i,t}^{1-\sigma} c_{i,g,t}^\sigma \lambda_{u,t} \alpha_{i,g}^\sigma w_{u,i,g,t}^{-\sigma}$$

$$(4) \quad \frac{\partial \bar{c}_{i,g,t}}{\partial w_{s,i,g,t}} = L_{s,i,g,t} = Y_{i,t}^{1-\sigma} c_{i,g,t}^\sigma \lambda_{s,t} \alpha_{i,g}^\sigma w_{s,i,g,t}^{-\sigma}$$

Finally, we make the simplifying assumption that the relative efficiency of the two types of labor changes at a constant rate over time, i.e.:

$$(5) \quad \ln \frac{w_{u,t}}{w_{s,t}} = \gamma \cdot trend.$$

Now, it is straightforward to derive a log-linear relative labor demand model by dividing equation (3) by equation (4) and taking logs on both sides. Adding an error term,  $\varepsilon_{i,g,t}$ , which accounts for other unobserved time-varying factors affecting relative employment, we get the following estimable relative labor demand equation:

$$(6) \quad \ln \frac{L_{u,i,g,t}}{L_{s,i,g,t}} = k_{i,g} + \gamma \cdot trend - \sigma \ln \frac{w_{u,i,g,t}}{w_{s,i,g,t}} + \varepsilon_{i,g,t},$$

where  $k_{i,g} = \lambda_{u,t} / \lambda_{s,t} \alpha_{i,g}^\sigma$  is an industry-experience group fixed effect, which refers to a particular experience group in a given industry and which does not vary over time.  $\varepsilon_{i,g,t}$  is a time-varying error term which is assumed uncorrelated both with the earnings ratio and over time as well as across industry-experience groups. Clearly, this specification implies some strong assumptions, including the restrictions that the elasticity of substitution is constant across industries or sectors, that production is strictly separable between the two types of labor and all other inputs and that, within the two skill groups, there is no substitution across experience groups. The restrictive assumption of a constant substitution elasticity is mitigated in the estimation in that we estimate equation (6) for various sectors of the economy separately and thus allow it to vary across these sectors. As to the separability assumption, the two most obvious additional inputs are highly skilled labor (graduates) and capital. For the reason mentioned above, reliable data on earnings of graduates, especially when disaggregated by labor market experience, is not available in our data base. However, we do not consider the separability assumption with respect to highly skilled labor a serious restriction, since graduates possess a distinct set of skills which are unlikely to be close complements or substitutes to other types of labor. The maintained assumption that substitution

elasticities do not differ between experience groups admittedly is a rather restrictive one, but the data unfortunately do not allow for a more flexible specification.<sup>9</sup> As to capital, Steiner and Wagner (1997) have shown that the inclusion of the stock or the cost of capital had only minimal effects on either the coefficient for the trend or the estimate for the elasticity of substitution between unskilled and skilled labor in manufacturing. Negligible effects of capital on the relative demand for unskilled and skilled labor were also found for Germany by Fitzenberger and Franz (1997) and Falk and Koebel (1997a, 1997b).

The estimation of equation (6) poses two obvious econometric problems. The first is the potential for simultaneity bias. Since relative wages and relative skills are determined simultaneously in the labor market, there exists the possibility that the earnings ratio is correlated to the error term in the relative labor demand equation. We therefore instrument this potentially endogenous variable by its lagged value. Steiner and Wagner (1997) present results indicating that this type of bias does indeed exist and that it is abated by using this methodology. The second problem relates to the efficiency of our estimates. Applying OLS to grouped data does not account for the relative size of the cells. Though unbiased, the estimates produced by this methodology are inefficient. As an alternative, we estimated the relative labor demand equation by weighted least squares (GLS) thereby incorporating information on cell size in the estimation.

## **4 Results**

We first present results for the whole economy and for various broadly defined sectors, where in each case estimation is based on the same specification of the relative labor demand model as given by equation (6). For the manufacturing sector, we also present estimation results where industries are differentiated at the two-digit level according to their import intensity and their rate of total factor productivity growth, respectively. Following Steiner and Wagner (1997), we thus try to shed some light on the issue of the relative importance of international trade and technological change as explanatory factors for the decline of the skills ratio.

### **4.1 Sectoral Analysis**

Table 2 contains the results of fourteen different regressions (seven for men and seven for women). For each gender, the relative labor demand equation was estimated over all industries, the whole manufacturing sector, construction and transportation, retail and wholesale trade, and the service sector. For the latter we also ran separate regressions on three different subsectors, i.e. personal services, business services and public services (defense and public safety is not included). In

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<sup>9</sup> Due to the relatively small number of observations, separate estimation of the model for each experience group yielded mostly insignificant parameter estimates.

all regressions, group specific fixed-effects were highly significant and, according to standard Hausman-tests (see, e.g., Greene 1993: 479) correlated with the regressors in the model. Hence, we estimated the models conditional on the group-specific fixed effects.

The results can be summarized as follows. For the pooled sample of all industries, the estimated coefficient of the time trend implies that the skills ratio has declined by about 3% (6%) per year for men (women). These estimates simply reflect the dramatic trend decline in the employment of unskilled labor referred to in section 2, though after taking into account changes in relative earnings and other factors accounted for by the included group-specific fixed effects. The time trend thus accounts for factors that have changed for all industries and experience groups in a similar fashion within the observation period. A negative trend coefficient would therefore not only capture common demand shift factors, but also reflects labor supply factors due to the general upgrading in the level of vocational qualification of the German workforce.

This labor supply explanation of the trend decline of the skills ratio seems consistent with the much faster decline of the skills ratio for women, whose level of qualification has improved markedly more than for men. Furthermore, this explanation is also supported by the quite uniform estimated value of the trend coefficient across broad economic sectors.<sup>10</sup> As the estimation results in Table 2 show, the trend coefficient in the regressions for women is always about double the size of that for men. On the other hand, if the trend decline in the skills ratio were mainly related to skill-biased technological change and/or intensified international trade with low-wage countries – the most prominent hypotheses in the economic literature – there would be little reason to expect these rather uniform differences between men and women and across economic sectors.

At the aggregate level, our estimates imply rather small values of the substitution elasticity between unskilled and skilled labor. In fact, the substitution elasticity seems to be not statistically significantly different from zero for both males and females. However, as the regression results for the various sectors show, this is mainly due to the high level of aggregation. For some sectors, we obtain quite large and statistically significant substitution elasticities. For males working in the manufacturing sector we replicate the estimate reported by Steiner and Wagner (1997) of a substitution elasticity of approximately  $-0.3$ , which is somewhat below the other previous estimates reported in section 3 above.<sup>11</sup> However, most of these

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<sup>10</sup> Both for males and females, an F-test cannot reject, at the 5% level, the hypothesis that the trend coefficients for manufacturing, construction and transportation, wholesale and retail trade, and personal services are equal. The relevant test statistics are 0.54 for men and 2.43 for women.

<sup>11</sup> Steiner and Wagner (1997, Table 1) report a value of  $-0.321$  for their specification (5) which also includes the lagged relative wage as an instrument and also the capital/output ratio as additional regressor. When they use the contemporaneous instead of the lagged earnings ratio in their

studies are based on highly aggregated data, do not differentiate between males and females and rely on a rather different grouping of employees by type of qualification. These estimates are, therefore, not directly comparable to the ones reported here. We also find a rather large substitution elasticity of about  $-1.4$  for males in construction and transportation, which roughly corresponds to the estimate reported by Falk and Koebel (1997a) for construction alone, but is smaller than the estimate obtained by Fitzenberger and Franz (1997) for that sector.<sup>12</sup> This sector traditionally employs a large share of all male workers with little or no vocational qualification.

For women, the estimated substitution elasticity for the manufacturing sector as well as for construction and transportation turned out insignificant. For women, the non-manufacturing sector that accounted for the largest portion of employment is personal services. The estimated elasticity of substitution for this sector is approximately  $-0.8$ . Thus, it again appears that, although the overall elasticity of substitution is small, in precisely the sector which traditionally employs women the elasticity of substitution is relatively large. The remaining results for women show either insignificant or, in the case of business services, a positive and marginally significant coefficient on relative earnings, results.

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specifications of the relative labor demand model they obtain a somewhat higher substitution elasticity of about  $-5$ .

<sup>12</sup> These authors do not directly report substitution elasticities between unskilled and skilled labor, but they can be derived from the reported cross-price ( $\epsilon_{s,u}$ ) and own-price elasticities ( $\epsilon_{u,u}$ ) according to the formulae  $\sigma_{u,s} = \epsilon_{s,u} - \epsilon_{u,u}$  (see Fitzenberger and Franz, 1997, Tabelle 3, Falk and Koebel, 1997a, Table 4). The results of Fitzenberger and Franz (1997) refer to males only, whereas Falk and Koebel (1997a) use aggregate data and thus cannot differentiate by gender.



## 4.2 Disaggregated Analysis for the Manufacturing Sector

In order to shed some light on sectoral differences with respect to the degree of import competition and technological change, we have estimated the relative labor demand function for the respective subsamples of manufacturing industries in Table 3. These subsamples were constructed by splitting the sample according to the quartile into which an industry's import share or rate of productivity growth falls. Here, we differentiate between industries with low, middle, and high import intensity and rate of total factor productivity growth, respectively.<sup>13</sup> By differentiating the manufacturing sector along these two dimensions, we hope to obtain some additional evidence to discriminate between the trade and technological change hypotheses of the trend decline in the skills ratio. Since there would be too many cells with only a few observations for women in quite a few manufacturing industries, we restrict this analysis to men.

As the differences in estimated coefficients on the time trend show, the autonomous decline of unskilled labor of 3% per year was rather uniform across industries with different import intensities. Thus, this more disaggregated analysis confirms the results from the previous subsection that there is little evidence for the hypothesis of negative trade effects on the employment of unskilled labor in German manufacturing.

**Table 3—Fixed effects estimates of the relative labor demand function by import intensity and rate of productivity growth, 1975 – 1990, men only.**

Variable	import intensity			rate of productivity growth		
	low	middle	high	low	middle	high
constant	-.721** (.037)	-.475** (.023)	-0.291* (.041)	-.382 (.052)	-.547** (.022)	-.507** (.032)
<i>trend</i>	-.030** (.002)	-.029** (.001)	-.033** (.002)	-.023** (.003)	-.028** (.001)	-.038** (.002)
$\ln w_{t-1}^r$	-.542** (.190)	-.221 (.130)	-.365 (.206)	-.348 (.257)	-.616** (.124)	.161 (.172)
# obs	412	908	239	185	969	405

<sup>13</sup> The "middle" category aggregates industries falling into the second and third quartile. We divided the observation period into three sub-periods (1975 – 1979, 1980 – 1984, and 1985 – 1990) and compared the relative position of each industry over time. It turned out that there was very little change in the industry ranking of import ratios in the observation period. The same also holds for the rate of total factor productivity growth which was obtained for each industry on the basis of a modified growth accounting procedure (see Steiner and Wagner, 1997).

$R_{adj}^2$	.935	.936	.937	.931	.937	.939
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Notes:

- $w^r$  is the relative earnings ratio, which is instrumented by its one-period lagged value.
- Disaggregation of industries by import intensity and rate of productivity growth as described in the text.
- Standard errors are given in parantheses below parameter estimates.
- A star "\*" indicates significance at the 5% level, two stars "\*\*" at the 1% level.

However, estimated substitution elasticities seem to differ by import share. The estimated value of about  $-0.5$  is above average in industries with relatively low import shares, compared to about  $-0.37$  in industries with high import competition. However, the latter elasticity seems rather imprecisely estimated (with a standard error of  $.206$ )<sup>14</sup>, and it is thus not clear whether there is in fact a statistically significant difference between these two sectors. In industries with import shares falling in-between these two sectors the coefficient on the earnings ratio is also only marginally significant.

The estimation results for the subsamples of industries defined by the rate of total factor productivity growth show that the autonomous decline of the skills ratio in industries with high growth rates in the observation period was markedly higher than in the other sectors. In the former sector, the trend decline in the relative demand of unskilled labor was about 4% per year, almost double the rate experienced in industries characterized by low rates of technological change. Assuming that the difference between the trend decline of the skills ratio in industries with a high (low) growth rate of total factor productivity proxies the effect of skill-biased technological change, this factor would explain at most half of the overall observed decline of the skills ratio in industries characterized by strong productivity growth.

The importance of relative earnings for determining the skills ratio at the industry level also depends on the rate of technological change. The substitution elasticity obtains its highest absolute value in industries where the rate of technological change neither is particularly high nor low. In the latter industries this elasticity is very imprecisely estimated, which is probably due to the small number of remaining observations in this sector. On the other hand, in industries with high rates of productivity growth changes in relative earnings seem to have no statistically significant effect on the relative demand for unskilled labor (the point estimate is even positive).

The results presented in Table 3 are rather insensitive to changes in the specification of the relative labor demand equation. Including the level of real output and the real capital stock or, alternatively, the capital-output ratio, the user costs of capital or the

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<sup>14</sup> The large standard error can be explained by the relatively small number of observations remaining in this sector.

relative price of intermediate inputs has very little effect on the estimated trend decline in the skills ratio and the substitution elasticity (see also Steiner and Wagner 1997, Table 1).

## **5 Summary and Conclusions**

Extending previous research by Steiner and Wagner (1997) for manufacturing to the whole West German economy we found that the dramatic decline of the employment of unskilled labor occurred in all industries within West German manufacturing, but to a varying degree. Although the reduction in the relative supply of unskilled labor has certainly contributed to this development, it is only part of the story. The decline in the relative demand for unskilled labor has also played an important role. We find that the substitution elasticity between unskilled and skilled labor is rather low in most sectors of the economy, except for the construction sector and personal services. In these sectors, earnings of unskilled workers have even increased relative to skilled workers in the observation period. Hence, cuts in relative earnings of unskilled workers in these sectors could have contributed to a stabilization of their relative employment level. In other sectors of the economy, the decline in the employment share of unskilled workers attributable to an inflexible earnings structure therefore seems to have been modest compared to the trend decline in the skills ratio.

From the quite uniform decline of the skills ratio across broad sectors of the economy and within the manufacturing sector between industries with different levels of trade integration we conclude that increased international competition had little direct effects on the relative employment of unskilled labor. On the other hand, the rather uniform decline of the skills ratio across all sectors of the West German economy and the much stronger trend decline of the skills ratio in manufacturing industries characterized by a relatively high growth rate of total factor productivity seems compatible with the alternative hypothesis of unskilled labor-biased technological change. This is also the hypothesis supported by most other studies for various countries (see, e.g., Berman, Bound, and Machin 1997, Machin and van Reenen 1997). However, technological change, too, can only explain part of the overall decline in the skills ratio in Germany. In particular, it does not explain the fact that the skills ratio has declined at a much faster rate for women than for men across all sectors of the German economy. This suggests that supply side factors, in particular the general upgrading of the level of educational and vocational qualification also has played an important role for the trend decline of the skills ratio. These supply side factors which could not be adequately taken into account in this study certainly merit to be more systematically explored in future studies on the relationship between structural change, the adjustment of relative earnings and the substitution of unskilled labor in Germany.

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## Data Appendix

We match sectoral information from the disaggregated national accounts and individual-level employment as well as earnings information from the Employment Register of the Federal Labour Office, the so-called "IAB-Beschäftigtenstichprobe", IABS for short (for details see Steiner and Wagner, 1997, 1998). The IABS is a 1% random sample of all dependently employed persons living in Germany who are covered by the social security system. The data base from which the IABS is drawn includes about 80 percent of all employed people in Germany. At present, the IABS covers the years 1975 to 1990. In each of these years, about 200,000 individuals were randomly sampled from the population. For our empirical analysis, the sample is restricted to full-time employed males and females, apprentices are excluded.

Aside from the very large sample size, the greatest advantage of the IABS is its supposedly reliable earnings data, although there are some shortcomings as described in Steiner and Wagner (1998). The IABS also contains information on an individual's vocational/educational qualification and age which can be used to construct skill groups as defined by the level of formal qualification and labor market experience. Following Steiner and Wagner (1997, 1998), we use the following three vocational/educational groups: no vocational/education degree, vocational degree/higher education, and university/polytechnical degree. Following usual practice, we define an individual's potential *labor market experience* as:  $age - years\ of\ schooling - six\ years$ . Years of schooling are derived from the highest vocational/ educational degree as described in Steiner and Wagner (1997, Table A1).

The IABS contains information on an individual's industry affiliation at the two digit-level. For the sectoral analysis in section 4.1 industries were aggregated as described in Table A1 below. For the more detailed analysis of the manufacturing sector section 4.2, industries were aggregated into 30 two-digit industries as described in Steiner and Wagner (1997, Table A2), where the classification of industries by quartile of import share and growth rate of total factor productivity, respectively, is also given.

**Table A1 Industry Classifications in the IABS**

<b>IABS Code(s)</b>	<b>Description</b>	<b>sector/subsector</b>
00-08	agriculture, forestry, fishing, energy and mining	agriculture, mining
09-13	chemical products, oil products, rubber	manufacturing
14-24	stone, clay, glass, primary metals, fabricated metals	manufacturing
25-32	mechanical machinery	manufacturing
33-39	data processing, office and electrical machinery	manufacturing
40-58	lumber, furniture, paper, printing, leather, textiles, food, tobacco	manufacturing
59-61	construction	construction
	wholesale & retail trade	trade
63-68	transportation	transportation
	credit & insurance	business services
70-71	restaurants, hotels and accommodations	personal services
72-73, 86	barbers, cleaning services, and other services	personal services
74-75	educational services	public services
	art and theater	public services
	publication and literature	business services
79-81	law, financial consulting, arch., engineering & real estate	business services
82-83	marketing and photography	business services
78, 84	hygiene, medicine and veterinary services	personal services
	auction houses	business services
87-89	NGO's, politics, and churches	public services
	private homes	personal services
91, 93	General public administration & social security	public services
	defense and public safety	public services
	representation of foreign nations	public services



## Nontechnical Summary

The differential labor market developments in West Germany and in the United States are often cited to support the hypothesis of a trade-off between more jobs for unskilled workers on the one hand, and a less equal earnings distribution on the other. Unemployment of unskilled German workers increased substantially since the early 1980's while the distribution of earnings changed little. In this paper, we analyse the effects of the rigid German earnings structure on the relative demand for unskilled labor. Potential effects of intensified international competition and skill-biased technological change on the relative employment and of unskilled labor are also discussed.

A crucial parameter for the evaluation of the hypothesis that the decline in the relative employment of unskilled labor is the substitution elasticity with skilled labor. A relatively high absolute value, say larger than one, would indicate that a small change in relative wages has a relatively large impact on relative employment. Under such conditions, a relative supply or demand shock affecting especially unskilled labor could lead to a marked increase in this factor's relative employment in the presence of rigid wages. On the other hand, if the elasticity of substitution is low, then even a large adverse shock would be unlikely to significantly affect relative employment levels.

For Germany, estimates of the substitution elasticity between unskilled and skilled labor vary a great deal between the various studies, depending on the economic sector analyzed, the time period, the way skills are measured and the specification of the production technology. We find that the substitution elasticity between unskilled and skilled labor is rather low in most sectors of the economy. However, the substitution elasticity is relatively high for males in the construction sector and for females in personal services. In these sectors, earnings of unskilled workers have even increased relative to skilled workers in the observation period. Hence, in these sectors reductions in the relative earnings of unskilled workers could have contributed to a stabilization of their relative employment level. In other sectors of the economy, the decline in the skills rate, i.e. the employment share of unskilled relative to skilled workers, attributable to an inflexible earnings structure seems to have been modest compared to the trend decline in the skills ratio.

The skills ratio has declined by about 3% (6%) per year for men (women): This decline has been relatively uniform across sectors of the economy. We find some modest effects from technological change on the employment share of unskilled labor in the manufacturing sector, whereas international trade with low-wage countries is rejected as an explanation for the trend decline of the skills ratio by our results. However, supply side factors, in particular the general upgrading of the level of education and vocational qualification seem to have played an important role here.

# **Industrial Change, Stability of Relative Earnings, and Substitution of Unskilled Labor in West Germany<sup>\*)</sup>**

by

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## **Abstract**

We analyze the dramatic decline of the employment share of unskilled labor in the West German economy, in particular its relation to the relatively rigid earnings structure. We find that the substitution elasticity between unskilled and skilled labor is rather low in most sectors of the economy. However, the substitution elasticity is relatively high for males in the construction sector and for females in personal services. In these sectors, earnings of unskilled workers have even increased relative to skilled workers in the observation period. Hence, in these sectors reductions in the relative earnings of unskilled workers could have contributed to the stabilization of their relative employment level. In other sectors of the economy, the decline in the skills ratio, i.e. the employment share of unskilled relative to skilled workers, attributable to an inflexible earnings structure seems to have been modest compared to the trend decline in the skills ratio. The skills ratio has declined by about 3% (6%) per year for men (women). This decline has been relatively uniform across sectors of the economy. Potential effects of intensified international competition and skill-biased technological change on the relative employment and earnings position of unskilled workers are also discussed. We find some modest effects from international competition and technological change on the employment share of unskilled labor in the manufacturing sector.

**JEL classification: J23, J31, F16, O33**

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