Oxford Economic Papers 3 (2001), 582–603 **582**

Skill compression, wage differentials, and employment: Germany vs the US

By Richard Freeman* and Ronald Schettkat†

* Harvard University, National Bureau of Economic Research, and Centre for Economic Performance, LSE
† Department of Economics and Policy Studies, Utrecht University, PO Box 80.140, NL-3508 TC Utrecht, The Netherlands; e-mail: r.schettkat@fss.uu.nl.

Germany's more compressed wage structure is widely viewed as the main cause of the German-US difference in employment and unemployment, but part of the compression is due to Germany having a narrower distribution of skills than the US. Even adjusted for skills, however, we find that Germany has a more compressed wage distribution than the US. But relatively little of the US-German employment difference can be attributed to the compressed wage distribution. We find that jobless Germans have nearly the same skills as employed Germans and look more like average Americans than like low skilled Americans, which runs counter to the wage compression hypothesis. Given these patterns, the pay and employment experience of low skilled Americans is a poor counterfactual for assessing how reductions in pay might affect jobless Germans.

1. Introduction

The most popular explanation for the smaller creation of jobs in Germany than in the US in the 1980s and 1990s is the wage compression hypothesis. This hypothesis has two parts: first, that institutionalized wage setting in Germany compressed the wage structure relative to the market determined wage structure in the US; and second that the compression of wages reduced employment. Higher pay in the bottom rungs of the wage distribution in Germany, the argument goes, cut off low skill jobs, particularly in the service sector. The implication is that only by reducing pay and increasing inequality can Germany achieve US levels of employment and unemployment (Siebert, 1997).

There is empirical plausibility to this argument. As Table 1 shows, the distribution of wages[1] is much narrower in Germany than in the US and much of the difference between US and German employment per adult is found in the service sector. In addition, during the period when the employment-population rate fell in Germany relative to the US and when the German unemployment rate rose relative to the US unemployment rate, the dispersion of pay rose in the US but held steady

[1] Wages are calculated as monthly earnings divided by hours worked.

Table 1 Wage dispersion, employment-population rates and unemployment rates, Germany and US, 1973–1995

	Ratio of wages male workers D9/D1		Employment-population rates (×100) Total		Employment-population rates (×100) Services		Rate of unemployment	
	Germany	USA	Germany	USA	Germany	USA	Germany	USA
1973–79	2.4	3.2	66.5	65.2	31.4	41.3	2.7	6.5
1979–89	2.3	4.0	63.8	68.6	33.6	46.1	5.6	7.2
1989–95	2.3	4.1	65.9	72.2	37.0	51.3	5.7	6.2
Change 73/79 to 89/95	−0.1	0.9	−0.6	7.0	5.6	10.0	3.0	−0.3

Source: wage deciles from OECD Employment Outlook, 1973–79 data for 1979 in the US, 1983 in Germany; 1979–89 from 1989 in both countries, 1989–95 from 1994=3 both countries (OECD, 1995, 1997, 1998). Employment-population rates, CGAS; unemployment rates, as defined by BLS to be comparable (BLS, 1997).

in Germany. Thus the wage compression story seems to fit both cross-section and time series evidence.

But there is another potential explanation for the difference between the US and German wage structures which runs counter to the wage dispersion explanation of joblessness. This is that the distribution of skills is itself more compressed in Germany than in the US (Nickell, 1997; Nickell and Bell, 1996; Nickell, 1998). If less skilled workers are more skilled in Germany than in the US while German and American skilled workers are similarly skilled, some of the narrow dispersion of wages in Germany would represent a compression of skills. Measured in efficiency units, the German wage distribution would be more dispersed than nominal wages indicate, cutting the ground under the wage compression argument.

So, how different are the German and the US skill distributions overall and among types of workers? To what extent do skill differences explain the lower dispersion of wages and return to education in Germany than in the US? Are low-skilled workers better paid in Germany than in the US because they are more skilled or because Germany relies on institutions to set wages?

These are difficult questions to answer, in large part because we lack good measures of labor skill across countries. The most commonly used measure, years of schooling, is not directly comparable between the US and Germany because the two countries have very different educational systems. German education involves apprenticeships, which differ greatly from formal schooling in the US, so that it is necessary to develop some mapping between apprenticeships and formal schooling to make valid comparisons. The content or quality of German education and American education also differs. Even ideal comparable measures of education, moreover, may not fully capture the workplace competencies that underlie individual productivity and wages.

In this study we deal with these problems by examining three measures of skill: equivalence classes between US and German schooling that we develop; scores on the quantitative part of an adult literacy test (numeracy skills); and years of schooling. To link skills with employment, and wages, we use the Comparable German American Sectoral (CGAS) Database; and the OECD's Adult Literacy Survey (IALS).

The CGAS takes data from the US Census of Population, the Current Population Survey, and the German Mikrozensus and social security files (Beschaeftigtenstatistik) to develop employment and wages for workers in comparable detailed demographic, education, occupation, and industry cells. It covers the period 1970 to 1995. The CGAS lacks observations on individuals, but it has information on workers in enough cells (theoretically up to 1.2 million cells per year, though some cells are empty and others have too few observations to be useful) to provide substantial cross-section and time series variation in relevant variables. The Appendix provides a brief summary of the data; for more details see Freeman and Schettkat (1998).

The International Adult Literacy Survey is a multi-country study that measures the ability of adults to understand and use printed information through reading, writing, and numeracy, in their workplace and daily life. It is the first major international study focused on the workplace-related literacy skills that workers have. It includes data on employment, unemployment, income, and other socio-economic variables. Because numeracy is modestly more closely related to economic outcomes than reading or writing, we use the numeracy scores in this study, though all of our results also hold for the other measures or composites thereof.

We find that:

(i) Measured in equivalent skill units or in numeracy scores, Germany has a more skilled work force than the US. Germany also has a more compressed distribution of skill. This contrasts with the data on nominal years of schooling, which show that Germany has fewer years of education and a more dispersed distribution of those years.

(ii) Most of the difference in skills between American and German workers is in the bottom rungs of the skill or education distribution, where Americans have much lower numeracy skills than Germans. About half of this difference is due to low-skilled immigrants to the US, though some native-born Americans have very low skills as well.

(iii) The widespread belief that American schools do not work well notwithstanding, each year of schooling in the US adds more in numeracy skills than a year of schooling in Germany. But the US trails Germany by so much in skills at the lowest levels that it does not attain equality in skills until the 15th year of education.

(iv) The narrower dispersion of skills in Germany than in the US explains only a modest proportion of the lower dispersion of wages in Germany, leaving a considerable role for institutional factors in compressing the German wage distribution.

(v) The skills of jobless Germans are closer to those of employed Germans than the skills of jobless Americans are to those of employed Americans. Jobless Germans have skills comparable to those of employed Americans.

In short, comparisons of the dispersion of wages and relative wages based on measured wages exaggerate US-German differences in the distribution of wages in efficiency units. Still, even skill adjusted, Germany has a more compressed wage distribution than the US, leaving space for the wage compression hypothesis to explain employment patterns. But we find that German joblessness has little of the structure that one would expect from a distorted wage structure: jobless Germans have nearly the same skills as employed Germans and look more like average Americans than like low-skilled Americans.

2. Schooling and skill equivalence groups

2.1 Skill distributions measured by equivalence groups

The most readily available measure of skills across countries is years of schooling attained. If all school systems operated more or less similarly, years of schooling would be a reasonable indicator of the skills obtained from the formal educational system. The United Nation's International Standard Classification of Education (ISCED) would measure accurately skill attainment across countries. However, schooling systems differ greatly across countries so that a year of schooling in one country does not produce the same human capital as a year of schooling in another. Differences in the skills young persons obtain from their home and social environment also produce differences in workplace competencies. Young persons with nominally the same schooling score differently on standardized international tests of attainment.

Because Germany relies on apprenticeships to teach young persons work relevant skills, it fits poorly into standard international classifications. Apprenticeships combine part-time schooling and part-time on-the-job training, which will give Germans with a given number of years of full-time schooling more skills than Americans with the same years of full-time schooling. Thus, our first task for comparing US and German distributions of skills is to develop an equivalency between Germany's skill creation through apprenticeships and years of schooling and American skill creation through formal schooling.

Figure 1 shows the equivalence scale that we have established. We view Americans with masters degrees or more and Germans with university degrees as equivalent; and set US bachelors graduates and Germans with Fachhochschule, Arbitur + Fachhochschule as equivalent. By these scales, Germans have a higher proportion of workers in the highest skill category while Americans have a higher proportion in the second highest group. Taking these two groups together, the US

Level	US Grades	US Employment share	US Skill scores (numeracy)	Years of schooling	Germany Employment share	Germany Skill scores (numeracy)	Germany Grades
I	9^{th} grade - 10^{th} grade 11^{th} grade Highschool graduate	45	245	≤9 10 11	16	278	No certificate Hauptschule Realschule
				12	69	300	Hauptschule + Apprenticeship Realschule + Apprenticeship; Abitur Hauptschule + Meister Realschule + Meister
II	Some college, no degree Associate degree	30	294	13 14 15			
III	Bachelor's degree	17	322	16 17	7	311	Fachhochschule Abitur + Fachhochschule
IV	Master or higher	8	331	18+	8	327	University degrees

Fig. 1. Equivalent skill levels. *Source*: Own estimates, skill scores are the mean of five quantitative scores (numeracy) from IALS, the skill measure is computed including immigrants, the population is 20–65 years.

has relatively more highly skilled workers than Germany. In the least skilled groups we have put Germans with no certificate and Americans who have not graduated from high school. The difficult question is how to treat Germans with some completed apprenticeship and Americans with high school degrees or with some post-secondary education but no bachelors degree. Apprenticeship gives Germans more skills than American high school graduates with no additional training. We categorize those with Hauptschule and Apprenticeship as comparable to US high school graduates; those with Realschule + Apprenticeship; Abitur as having 13 years of schooling; those with Hauptschule + Meister as having 14 years; and those with Realschule + Meister as having 15 years of schooling.

The resultant distribution of workers by level of skill differs between the two countries. The vast bulk of Germans are in the second skill category while Americans are widely dispersed across groups, with 45% falling into the lowest skill category. Overall, Germans are more skilled, due to the large fraction of Americans in the lowest category and Germans have a more compressed distribution of skills, due to the concentration of Germans in the second skill category.

If our equivalency scales are roughly correct, Americans with just a high school degree should have numeracy scores roughly equal to those of Germans with less than upper secondary education, whereas Germans with less than upper secondary education should have scores roughly equal to the mean score for the US. This turns out to be the case (Freeman and Schettkat, 1999). Fifty per cent of Germans who have not completed upper secondary education (our skill equivalent I in Fig. 1) scored higher than 277 which is the US average on the numeracy scale. Of the American in our skill equivalent group I only 30% scored higher than 277 on the numeracy scale and even among the high-school graduates only about 40% scored higher (compare also OECD, 1997). Thus, placing Germans with less than upper secondary education on a par with American high school graduates, and Germans with more education on a par with Americans with some post-high school education fits the numeracy score data. Although we did not create the equivalence scales to equate numeracy scores, the numeracy scores in the columns labeled 'skill scores' show that three of our four groups have similar scores for Americans and Germans, though the lowest skilled Americans have lower scores than the lowest skilled Germans.

How much of the narrower distribution of wages in Germany than in the US might be attributable to differences in the distribution of skills?

To answer this question, we performed a two-part analysis. First we regressed log wages on dummy variables for our measures of skill

$$\ln W = a + b_2D_2 + b_3D_3 + b_4D_4 + u \tag{1}$$

where the lowest skill group is deleted and where Di reflects the ith skill group and bi is its estimated effect on wages relative to the deleted group. Then we used the resultant regression coefficients to examine the impact of the difference between the US and German distributions among the groups on the standard deviation of log wages of workers in the two countries.

Table 2 Contribution of skill category to the standard deviation of log wages, US and Germany, 1995 CGAS files, workers 20–64

	USA	Germany
1 Standard deviation of ln(wage)	0.466	0.335
2 Standard deviation of residual [ln(wage) regressed on skill equivalents]	0.399	0.288
3 Coefficients (Std errors) on dummy variables for		
Skill equivalent II	0.162 (0.004)	0.288 (0.004)
Skill equivalent III	0.498 (0.005)	0.605 (0.005)
Skill equivalent IV	0.738 (0.007)	0.625 (0.006)
4 Standard deviation of ln(wage) with other country's distribution across skill groups	0.444	0.381
5 Standard deviation of ln(wage) with other country's coefficient of skill groups	0.470	0.348
6 Standard deviation of ln wages within skill groups		
Skill equivalent I	0.400	0.360
Skill equivalent II	0.411	0.290
Skill equivalent III	0.391	0.200
Skill equivalent IV	0.361	0.155

Source: computations based on CGAS. Sample size for US 47068 cells; for Germany 42764 cells, weighted with cell sizes.

Line 1 of Table 2 shows the raw standard deviation of log wages in Germany and the US across cells in the CGAS: one measure of the phenomenon to explain.[2] By this metric, the dispersion in the US is 0.13 log points higher than in Germany. Line 2 records standard deviations of residual wages from the simple regression of log wages on dummy variables for skill groups. The standard deviation in the US falls by 0.07 log points while that in Germany falls by 0.05 points, reducing the difference in standard deviations by 0.02 log points or 15% of the initial difference.

Line 3 of Table 2 records the *b* coefficients on our three skill equivalence groups from the log wage equation. Being in the 2nd skill category rather than the first (omitted) group has a larger impact on wages in Germany than in the US, despite the fact that the numeracy scores differ less in Germany than in the US between these two groups. The differential between the 3rd and 2nd skill groups and between the 4th and 3rd skill groups is, on the other hand, larger in the US. The biggest difference in the structure of wages occurs at the upper end of the skill distribution, where Germans earn a smaller premium than Americans.[3]

[2] These figures are based on cells that vary by years of schooling, age groups, industry, occupation, and gender, immigration status. Since they give all persons within a cell the same wage, they understate the standard deviation in log wages in both countries. In the following analysis all results are based on data weighted by cell sizes.

[3] The original source for wages in the CGAS is the Beschäftigtenstatistik, which is censored at the high wage end because of the ceiling for social security contributions (see Möller for a discussion). Therefore, we underestimate wage dispersion in Germany. Whether this leads to overestimation of German-US difference in wage dispersion is not clear because fringe benefits (not measured as wages) are more important among high-income Americans.

The remainder of Table 2 records the results of calculations that show the dispersion in log wages that Germany or the US would have if it had either the other country's dispersion of skills, or return to skills.[4] To obtain these estimates, we take the variance of eq. (1) to get

$$\begin{aligned}\mathrm{Var}\,(\ln W) &= b_2^2\,\mathrm{Var}\,(D_2) + b_3^2\,\mathrm{Var}\,(D_3) + b_4^2\,\mathrm{Var}\,(D_4)\\ &\quad + 2b_2b_3\,\mathrm{Var}\,(D_2D_3) + 2b_2b_4\,\mathrm{Var}\,(D_2D_4)\\ &\quad + 2b_3b_4\,\mathrm{Var}\,(D_3D_4) + \mathrm{Var}\,(u) \qquad (2)\end{aligned}$$

Line 4 gives the dispersion in wages that each country would have if it had its own returns to skill, reflected in the b coefficients, but the other country's distribution of skills, and its own residual variance of wages. That is, we replace the σ^2 Ds in equation (2) with the σ^2 Ds from the other country. Since so many Germans are in the 2nd skill category, giving the US the German distribution of skills reduces the dispersion of wages in the US, while giving Germany the US distribution of skills raises the dispersion of wages in Germany. The standard deviation of log wages in the US would be 0.022 points lower if the US had the German skill distribution while the standard deviation of log wages in Germany would be 0.046 points higher if Germany had the US distribution of skills. Thus, giving the US the German skill distribution explains 17% (0.022/0.131) of the initial 0.131 difference in the dispersion of earning between the countries; while giving Germany the US skill distribution explains 35% (0.046/0.131) of the initial difference.

Line 5 shows the distributions of wages with the other country's coefficients of skill groups, which deviate only slightly from the initial distributions in line 1. Another way to gauge the contribution of cross-country difference in the distribution of skills on the cross-country difference in the distribution of wages, therefore, is to look at the dispersion of skills within the same skill categories. Line 6 of Table 2 records the standard deviation of log wages within skill categories for the countries. It reveals little difference in the standard deviations for the lowest skill group, but shows that the US has 0.12 log units higher standard deviation of pay in the key 2nd skill group and even higher standard deviations of log pay in the next two categories. Again, the greatest difference in the dispersion of pay between the US and Germany occurs in the upper part of the skill distribution, not in the lower part.

2.2 Schooling tells a different story

What if we use reported years of schooling rather than our skill equivalence groups in the analysis, treating years of schooling as comparable between the countries?

In this case, the data would contravene the skill compression story. This is because the distribution of years of schooling for Americans is higher and more concentrated about the mean than the distribution of years of schooling for

[4] This is without taking account of how the different distribution of skills might affect the return to skills.

Table 3 Components of the standard deviation of log wages, US and Germany, 1995 CGAS files, workers 20–64 years

	USA	Germany
1 Standard deviation of ln(wage)	0.466	0.335
2 Standard deviation of residual [ln(wage) regressed on years of schooling]	0.390	0.283
3 b, coefficient of schooling (standard error)	0.1087 (0.0008)	0.0740 (0.0006)
4 Standard deviation of years of schooling	2.347	2.431
5 Predicted standard deviation of ln(wage) if coefficients for schooling (b) from the other country, initial residuals used	0.426	0.387
6 Predicted standard deviation of ln(wage) if distribution of schooling from the other country, initial residuals used	0.471	0.332

Source: computations based on CGAS. Sample size for US 47068 cells; for Germany 42764 cells, weighted with cell sizes.

Germans. In the CGAS the mean level of schooling (standard deviation of schooling) is 13.5(2.35) in the US compared to 12.9(2.43) in Germany.

But if the actual skill of workers with the same years of schooling in the two countries differs, comparing the distribution of years does not properly test the skill compression claim. Indeed, the skill compression hypothesis would predict that with such a metric, wages by skill group would differ between the countries. Skill compression would show up in lower returns to schooling in Germany than in the US, reducing the overall dispersion of pay by an amount roughly comparable to the amount that of reduction in dispersion that we obtained in Table 2.

In part, the CGAS data bear out this prediction. We regressed log wages on years of schooling across CGAS cells in 1995 and then decomposed the variances of log wages into the parts due to: the variance in educational attainment; the square of the coefficient on schooling in an log wage equation; and the variance of the residual in wages from the equation

$$\mathrm{Var}\,(\ln W) = b2\,\mathrm{Var}\,(S) + \mathrm{Var}\,(u) \qquad (3)$$

The standard deviation of the residuals from these regressions, $\mathrm{Var}\,(u)$ measures the dispersion of wages within a country for workers conditional on the value of a year of schooling, b, and the dispersion of years of schooling, $\mathrm{Var}\,(S)$. Differences in overall dispersion of wages between the US and Germany can be attributed to differences in the three components.

Line 1 of Table 3 shows again the raw standard deviation of log wages in Germany and the US across CGAS cells. Line 2 records standard deviations of residual wages from the univariate regression of log wages on years of schooling. The standard deviation in the US falls by 0.08 log points while that in Germany falls by 0.05 points and the difference in the variance of log wages between the US and Germany is 18% less after controlling for schooling. Lines 3 and 4 show that the greater decline in standard deviations of log wages in the US than in Germany results from the higher coefficient on schooling. The coefficient on years of schooling in the wage equation is 0.11 across cells in the US compared to 0.07 across cells in Germany. By contrast, line 4 documents that the standard deviation in years of schooling is lower in the US than in Germany, which by itself would make dispersion of wages less in the US. Line 5 shows that the standard deviation of log wages in the US would fall by 0.04 points to 0.42 if schooling had the same return in the US as in Germany. Conversely, the standard deviation of log wages would rise by 0.05 points in Germany if it is combined the US return to schooling, the German dispersion of schooling, and the German residual variance. Line 6 shows that using the other country's distribution of schooling but the own country returns to education changes the standard deviation of log wages by just 1%. These results are roughly consistent with the skill compression hypothesis only if we interpret the lower coefficient on years of schooling in Germany as reflecting smaller differences in real skills by level of schooling in Germany. And most of the difference in standard deviations occurs among workers with similar years of schooling.

In sum, our measure of equivalency scales of skill supports the skill compression story, but if years of schooling measure skill, we must assume that differences in returns to schooling are due to differences in skills to interpret the relation between years of schooling and wages in a similar fashion. If we had no other measure of skills, it would be hard to convince the skeptic that skill compression is that important. But we have one additional way to compare skills between Americans and Germans: interms of numeracy scores on the OECD's adult numeracy survey.

3. Skill distributions measured by numeracy scores

3.1 Distribution of numeracy scores

In the early 1990s the OECD developed the International Adult Literacy Survey (IALS) a cross-country study that used the same survey instrument to measure the ability of adults to understand and use printed information through reading, writing, and numeracy, in their workplace and daily life. It is the first major international study focused on the literacy skills that workers have and use at workplace. While paper-and-pencil tests do not reflect all workplace productivity they offer a potentially better measure of skills in Germany and the US than years of schooling.

Figure 2 shows the distribution of numeracy scores in Germany and the US. The German skill distribution is more symmetrical and concentrated around the mean than the US skill distribution. The standard deviation of the scores in Germany (0.16) is approximately half the standard deviation in the US (0.30). The main reason is that a substantial number of American workers but virtually no Germans have exceptionally low scores. Indeed, while the mean and median of the skill distributions differ by just 7–8 points, at the 25th percentile Americans score 29 points lower than Germans, while at the 5th percentile, they score 77 points lower.

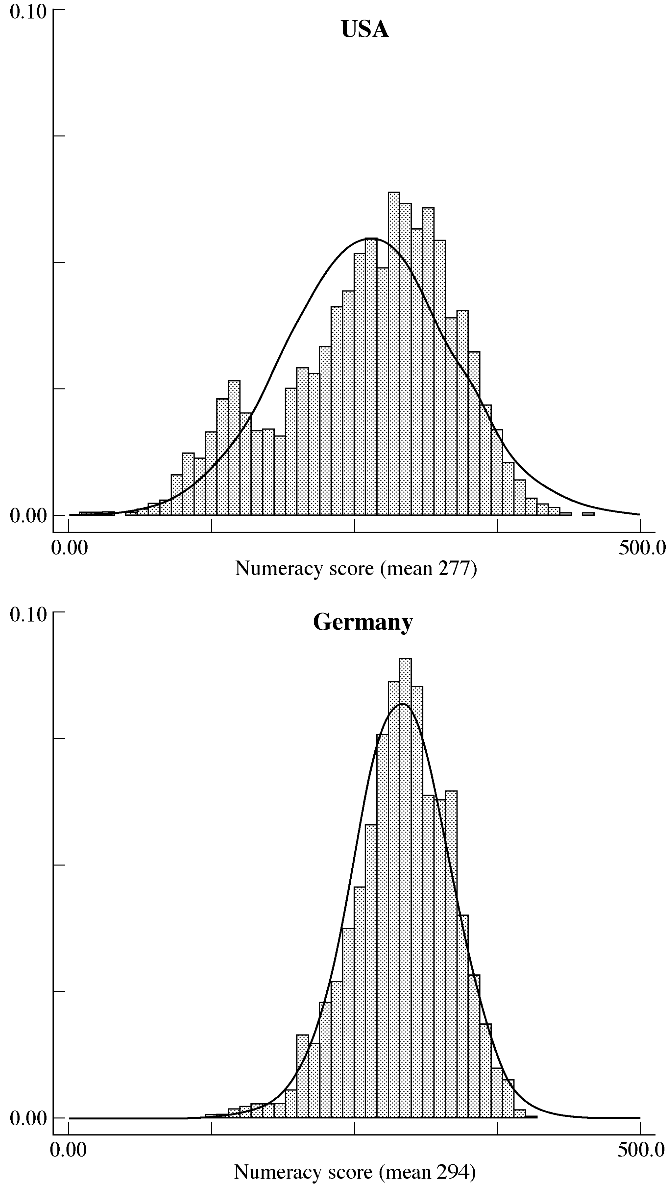

Fig. 2. Numeracy scores, population 20–64 years

One reason why the US has so many workers with exceptionally low scores is that 13% of Americans in the IALS are immigrants, whose score on a test in English may understate their true labor market skills. Immigrants averaged 217 on the numeracy score, which is 60 points below non-immigrant Americans, and were disproportionately represented among those with exceptionally low numeracy

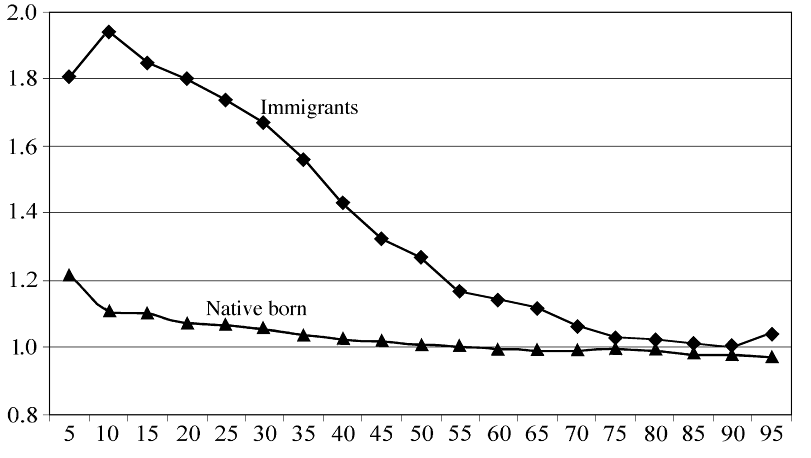

Fig. 3. Ratios of numeracy scores by percentiles, population 20–64, German score/US score. *Source*: computations based on IALS, numeracy is the average score of five numeracy tests.

scores. By contrast, just 8% of Germans taking the IALS were immigrants, and these immigrants averaged 271 on their numeracy score, just 24 points below non-immigrant German citizens. If we eliminate immigrants from the sample, the standard deviation in numeracy scores among Americans falls from 0.30 to 0.23 while the standard deviation in numeracy scores among Germans is unchanged at 0.15. Thus nearly half of the difference in the dispersion of numeracy skills between the US and Germany is due to the low numeracy skills of US immigrants. Even so, there remains a sizable 0.08 difference in the standard deviation of skills of the native born between the two countries, again concentrated in the lower tail of the distribution.

Figure 3 records the ratio of the numeracy scores of Germans to Americans at the same percentiles for each distribution. Ratios greater than one indicate that Germans have higher numeracy than Americans, while ratios less than one indicate that Americans have higher numeracy. The line for non-immigrants shows a German advantage in skills in the lowest percentiles, falling to near equality around the middle of the distribution, and then falling to a slight disadvantage in the highest percentiles. The graph for immigrants shows that German immigrants are much more skilled in the lower rungs of the skill distribution and somewhat more skilled in the upper rungs.

How should we interpret the exceptionally low numeracy scores of low skilled American immigrants? Given the huge immigration into the US of persons with very limited schooling, largely from Mexico and Latin America, the scores arguably represent a true measure of skills. But to some extent, the scores reflect the fact that the native language of immigrants is not English. By living in immigrant enclaves, many persons largely illiterate in English can function in their own language. From this perspective, the low scores exaggerate the poor skills of these workers (Devroye and Freeman, 2000).

3.2 Schooling and numeracy scores: the skill formation of schooling

Thus far we have looked at schooling and numeracy scores as separate measures of skill. But these two measures are closely linked. Education produces higher levels of numeracy; and persons with high innate numeracy may invest in education more than others. To compare the relation between schooling and numeracy in Germany and the US, we examine the numeracy scores of non-immigrants with different years of schooling.[5] We exclude immigrants because most of them have received schooling elsewhere and because the scores of US immigrants arguably understate their skills.

Table 4 gives the mean numeracy score in each group, the score of the 5th, 50th, and 95th percentile and the standard deviation of the scores. The mean level of numeracy rises monotonically with years of schooling in both countries. But the link between schooling and numeracy differs. At the lowest levels of schooling, Germans have much higher quantitative scores than Americans, while at higher levels of schooling, Americans have modestly higher scores than Germans. In the underlying data for individuals the correlation between years of schooling and the numeracy score is 0.57 for the US and 0.35 for Germany. Finally, the standard deviations in numeracy scores within schooling categories are larger in the US than in Germany, concentrated also among low education groups.

The concentration of US-German differences in numeracy scores at the lower rungs of the education ladder suggests that years of schooling in the US are more effective in producing skills than years of schooling in Germany. To examine this, we take years of schooling as given and regress numeracy skills (N) on years of schooling (S)

$$N = a + bS + u \tag{4}$$

Table 5 gives estimates of eq. (4), with schooling as the sole independent variable and with age and with an age-schooling interaction term. Regressions I and II show that an extra year of schooling adds about 12 score points in the US compared to only about four points in Germany. German workers have greater average numeracy because the constant term in the regressions is greater for Germany than for the US. One interpretation is that primary schooling which everyone in both countries receive is more effective in Germany. Another is that German families or culture gives students more numeracy skills, schooling aside. The difference in the constant

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[5] There is a problem with the IALS measure of formal schooling in Germany. It ignores the years of apprenticeship, which Germans obtain. To see if this biases the analysis, we have compared years of schooling in the CGAS, inclusive of apprenticeship, and years of formal schooling in the IALS and developed an adjustment procedure for correcting the IALS observations to take account of apprenticeship. The procedure is described in Freeman and Schettkat (1999). The results with observed years of schooling and our adjusted years of schooling are similar.

Table 4 The distribution of numeracy scores (QUANT) by years of education (population 20–65 years, immigrants excluded)

Years of education	US Percentiles 5th	US Percentiles 50th	US Percentiles 95th	mean	sd (ln QUANT)	n	Germany Percentiles 5th	Germany Percentiles 50th	Germany Percentiles 95th	Mean	sd (ln QUANT)	n
9	96.5	213.5	305.6	203.7	0.341	163	213.5	282.8	348.4	283.0	0.152	500
10	108.8	230.7	307.3	225.2	0.288	121	212.8	292.9	353.7	290.7	0.151	413
11	140.8	237.9	332.4	233.9	0.241	109	213.3	285.2	342.8	285.8	0.135	133
12	186.2	276.6	347.0	273.3	0.187	568	234.1	299.0	349.9	297.3	0.126	171
13	216.8	299.0	384.3	295.5	0.154	147	235.5	306.0	363.3	305.2	0.120	164
14	223.8	298.1	365.6	295.7	0.154	231	228.5	302.2	357.7	302.1	0.136	75
15	242.1	310.9	366.4	305.6	0.142	95	242.2	318.6	369.4	312.3	0.137	70
16	251.4	326.5	396.4	326.1	0.138	274	258.0	323.8	377.0	321.0	0.122	63
17	232.8	334.5	394.3	330.2	0.136	89	246.4	313.5	368.9	311.1	0.118	44
18	277.2	334.3	391.7	335.2	0.126	107	264.2	323.3	377.8	319.8	0.114	39
19	272.9	344.9	394.1	338.9	0.123	59	290.1	341.3	374.2	338.9	0.085	41
20+	243.1	343.8	411.5	339.0	0.130	53	263.6	326.1	367.8	321.9	0.133	47
Total					0.230	2062					0.148	1777
Mean years of education						13.6						11.5

Source: calculations based on IALS; German years of education are not adjusted for apprenticeships, weighted with sample weights.

Table 5 Regressions of skills on schooling (population 20–65 years, immigrants excluded, OLS)

	US			Germany		
	I	II	III	I	II	III
Constant	127	129	69	244	265	239
	(5.3)	(6.5)	(20.5)	(3.6)	(5.3)	(13.3)
Years of education	11.9	11.9	16.4	4.4	4.0	6.2
	(0.4)	(0.4)	(1.5)	(0.29)	(0.29)	(1.1)
Age	—	−0.05	1.3	—	−0.4	0.2
	(0.01)	(0.4)		(0.08)	(0.3)	
Age*education	—	—	−0.1	—	—	−0.05
		(0.03)			(0.02)	
Dummy	—	—	—	—	—	—
R^2 adjusted	0.33	0.33	0.33	0.12	0.14	0.14

Source: IALS, Standard errors in parentheses, weighted with sample weights.

terms is sufficiently large that the US passes the German skill level on average only at about 15 years of schooling. Age coefficients are negative but small in both countries

The interaction between age and education in regression III is negative for both countries, suggesting that age and education are substitute ways of acquiring skills or, alternatively, that education has improved its effectiveness over time, so that the education of older cohorts raised numeracy less. The interaction is larger in the US than in Germany, implying that whatever underlies this pattern age or cohort effects has been more powerful in the US.

What are the implications of these findings for the skill compression hypothesis?

The narrower dispersion of numeracy scores in Germany than in the US supports the implication of our equivalence scales that Germany has a narrower distribution of skills than the US. The evidence that US schooling adds more to numeracy than German schooling supports the skill compression interpretation of the lower return to schooling in Germany. At least in part, Germany has a smaller return to years of schooling because skills are more weakly associated with years of schooling than in the US.

But the numeracy data also reveal problems with the skill compression story. We have seen that the dispersion of wages differs most between the US and Germany among persons in the highest skill categories. If the underlying cause was the dispersion of numeracy, we would expect greater dispersion among those with more skills. But the dispersion of numeracy differs most among persons in the lowest categories. Our equivalent skill categories of Fig. 1 tell the same story. In Germany the standard deviation of log wages and of log skills falls from the least to the most skilled group, consistent with the skill compression story. But in the US the skill groups have similar standard deviations of log wages (around 0.40) but different standard deviations of log skills, which fall between the lowest group (0.33) to the highest group (0.16). The higher dispersion of wages among the most skilled/educated in the US than in Germany does not reflect differences in the distribution of skills among those two groups.

4. From compressed skills to compressed wages

To what extent does the compression of skills in Germany compared to the US contribute to the lower dispersion of wages and return to education in Germany than in the US?

We analyze this question by regressing log income on numeracy scores and education in the IALS.[6] The IALS records personal income, which necessarily differs from the hourly wages in the CGAS. It differs between Germany and the US because the German data refer to incomes after taxes while the US data refer to incomes before taxes. In addition, there is a data problem for Germany: the IALS does not provide actual incomes of Germans, but rather records the position of workers in the German income distribution in 20 categories defined by their percentile. To deal with this problem we transformed the percentile measures in the German distribution into incomes at the mid point in the category where they fit, and used those numbers as our dependent variable for Germany. For comparability, we grouped the incomes of individual Americans in a similar fashion. Thus, each worker in both countries is assigned one of 20 income numbers, depending on where that worker fit in the national distribution.[7]

There are three ways to model the link between wages and skills when we have both numeracy scores and years of schooling as potential indicators of human capital. First, we can assume that schooling and other factors determine numeracy skills which in turn affect wages: Schooling > Numeracy Skills > Wages. This suggest that we regress log income on skills but not on schooling, and use the resultant b coefficient to assess the contribution of the compression of skills in Germany on the standard deviation of log income. Second, we can assume that schooling and other factors determine wages, and that numeracy is a background factor that affects schooling: Numeracy Skills > Schooling > Wages. This is the standard

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[6] In these calculations we used the sample weights in our regressions. Unweighted regressions yielded similar results.

[7] Grouping the data in this way had no noticeable effect on the regressions for the US workers, for whom we could run a regression with individual observations and a regression with grouped data. Compare, for instance, the regression coefficients and standard errors on log score and on education using individual data in the three models in Table 6:

Model I: log score, 1.003 (0.081) the same as in the table;
Model II: schooling, 0.094(0.007) slightly below the estimate in the table;
Model III: log score, 0.614(0.091); schooling, 0.068(0.008).

There are statistical ways to deal with the categorical variable problem (Stewart, 1983) but given the similarity between coefficients with grouped and ungrouped data, we chose the simple technique used in the text.

Table 6 The impact of skills and the payoff to skills on the log incomes and the dispersion of income, Germany and US, 1991 (controlling for age, age-squared, sex, and immigrant status)

	Model 1		Model 2		Model 3	
	Germany	USA	Germany	USA	Germany	USA
Lnscore	0.421 (0.130)	1.003 (0.081)			0.226 (0.134)	0.584 (0.092)
Educ			0.035 (0.006)	0.103 (0.007)	0.032 (0.006)	0.076 (0.008)
Age	X	X	X	X	X	X
Age^2	X	X	X	X	X	X
Male	X	X	X	X	X	X
Immigrant	X	X	X	X	X	X
Obs	924	1561	918	1545	918	1545
R^2	0.276	0.316	0.296	0.341	0.298	0.347
Standard deviations						
Initial	0.672	0.943	0.673	0.935	0.673	0.935
Residual	0.572	0.778	0.566	0.760	0.566	0.751
Pred. residual if other country's skill distribution	0.564	0.812	0.566	0.754	0.564	0.763

Source: computations based on IALS, adjusted as described in the Appendix, standard errors in parentheses weighted with sample weights.

human capital model. Third, we can assume that schooling and numeracy scores are equally valid indicators of human capital, so that the appropriate regression is log income on both measures.

Table 6 presents the results of estimating these models. The columns under model I give the results when incomes depend on the numeracy score and covariates but not on schooling. The estimated coefficients show that the elasticity of income with respect to numeracy skills is more than twice as large among Americans than among Germans.[8] Because the regression fits the US data better than the German data, the initial standard deviation of log incomes in the US (0.94) is reduced by 0.26 points to 0.78, while the initial standard deviation of log incomes in Germany falls by just 0.10 points (from 0.67 to 0.57), cutting the difference in dispersions by 0.16. If we replace the distribution of scores in Germany with the US distribution and the distribution of scores in the US with the German distribution, but keep each country's coefficients on log scores, we obtain the results in the bottom line. Increasing the dispersion of scores in Germany to the level in the

8 Limiting the sample to non-immigrants did not reduce the standard deviations for either country—in striking contrast to the huge effect of removing immigrants from the skill distribution in the US on the US skill distribution.

US has virtually no effect on the standard deviation of incomes because the coefficient on log score in the income equation is small. Reducing the dispersion of scores in the US to the German level modestly reduces the US dispersion.[9]

The estimates of models II and III go further in rejecting the notion that differences in the dispersion of skills explains US/German differences in dispersion of incomes. In model II the coefficient on years of schooling is much higher in the US than in Germany (seven points compared to four points in Fig. 1). We attribute this in part to the fact that in the IALS, we are comparing returns after taxes in Germany with returns before taxes in the US. Because years of schooling is less dispersed in the US than in Germany, there is a slight increase in the US dispersion of log incomes and a slight decrease in the German dispersion when we switch the dispersion of scores. With the dispersion of scores and the dispersion of years of schooling working in the opposite direction, we get very little impact in model III.

Still, taking account of the difference in numeracy scores does have a substantial effect on one German-US difference in income determination. In the regression of log income on years of schooling alone (with covariates), we obtain coefficients of 0.103 in the US and 0.043 in Germany. Inclusion of numeracy skills reduces the effect of schooling on incomes in the US by 0.027 points and reduces the effect on incomes in Germany by 0.003 points. Thus, 0.024 points of an initial 0.060 difference in the effects of schooling on incomes is attributable to the intervening effect of scores. Put differently, 40% of the difference in the impact of schooling on incomes between the countries is attributable to the differential pattern of skills across schooling groups.

But our principal finding in this section is that the narrower distribution of skills in Germany than in the US does not account for the bulk of the difference in dispersion of income between the two countries. There remains a sizeable difference in the distribution of incomes that presumably represents the effects of Germany's institutional wage setting vs the US's market wage-setting. Is this difference is associated with the composition of joblessness in the two countries consistent with the skill compression hypothesis?

5. Skills and joblessness

If the compressed wage structure in Germany cut off labor demand for low-skilled workers while the flexible wage structure in the US allowed low skilled persons to find work we would expect that low skilled persons would have a harder time finding work in Germany than in the US. As a result, a larger proportion of the jobless would be unskilled in Germany compared to the US.

[9] The only way these calculations substantively reduce the difference in dispersions between the countries is if we postulate that Germany/the US had the other country's dispersion of scores and the other country's estimated impact of scores on log income. In this case, we would get a rise in dispersion of log incomes in Germany of 0.06 points and a fall in the dispersion of log incomes in the US of 0.05 points.

Table 7 Distribution of skill scores by labor force status, population 20–64 years (including immigrants)

	USA			Germany		
Score	employed	unemployed	not in labor force	employed	unemployed	not in labor force
−200	9.0	28.3	21.0	0.8	2.0	3.6
200–250	14.3	17.6	20.3	9.9	24.3	16.4
250–300	30.6	27.1	27.6	38.3	39.2	43.9
300–350	31.7	23.5	24.6	41.1	27.9	29.7
350–400	13.4	3.4	6.2	9.9	6.6	6.5
400+	1.1	0.0	0.2	0.0	0.0	0.0
Mean score	287	242	255	300	281	285
Ratio to mean score of the employed (%)	100	84	89	100	94	95
% with score below median of the employed	50	72	66	50	66	64
% with score below the mean of the employed	45	67	62	49	65	64
Average score of persons with scores below mean of employed	233	203	214	268	256	260
Ratio to mean score of the employed below the mean (%)	100	87	92	100	96	97

Source: Computations are based on IALS.

Table 7 compares the distribution by numeracy scores of the employed, the unemployed and of persons out of the labor force in Germany and the US. What stands out in the table is the greater difference in numeracy scores between the employed and the jobless groups in the US than in Germany. The mean scores for the unemployed and out of the labor force in the US are 16% and 11% below the score of the employed; whereas German unemployed and out of the labor force persons have scores only 6% and 5% below those of employed Germans. Seventy-two per cent of unemployed Americans have scores below the median for employed Americans compared to 66% of unemployed Germans below the median score for employed Germans. However, because the mean numeracy for the US is below the median, while the mean and median numeracy for Germany are similar, the percentage of unemployed Americans with scores below the mean employed American is comparable to the percentage of unemployed Germans with scores below the mean employed German. Here, the big difference is in the magnitude of the gap separating the skills of the low skill unemployed from the average employed

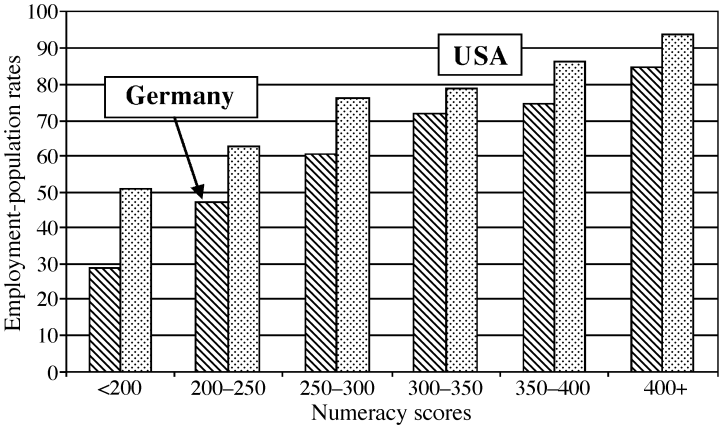

Fig. 4. Employment-population rates by Literary Score, 20–64 years. *Source*: computations based on IALS. * Germany '<200' has a share in employment of 0.8% only.

worker. Unemployed Americans with scores below the mean of the employed have numeracy scores 13% below the mean of employed Americans with below average scores while unemployed Germans with scores below the mean of the employed have numeracy scores just 4% below the mean of the employed Germans with below average scores.

Even more striking, the distributions in the table shows that virtually no unemployed Germans have scores as low as those of unemployed Americans. Among the unemployed the 5th percentile of the German unemployed scores as high as the 40th percentile of the American unemployed. For the employees, the gap is smaller the score of the 5th percentile of the German employees is only reached by the 20th percentile of the American employees.

This pattern is inconsistent with the wage-compression hypothesis. In Germany, where the wage structure is supposedly so compressed as to price out low skill workers, they are reasonably skilled, whereas in the US where flexible wages are supposed to reduce structural unemployment problems, the unemployed are much lower skilled than the employed.

This does not, however, mean that the less skilled are not more likely to be jobless in Germany than the more skilled. Figure 4 rearranges the numeracy-job status data to show the rates of employment for persons with given levels of numeracy skills. In Germany as in the US those with greater numeracy scores have higher employment rates (and lower unemployment). Indeed, the gap between the least skilled and more skilled is somewhat steeper in Germany than in the US, as the wage compression hypothesis would predict. But there are exceedingly few Germans in those low skill categories. In this sense, the data support the Nickel-Bell argument that Germany does not have many low skill jobs because it lacks truly low skill workers.

6. Conclusion

Our examination of the distribution of skills in Germany and the US has shown that Germany has a more compressed distribution of skills than the US, due to the absence of a lower tail of less skilled workers, as is found in the US. But the compression of skills explains only a modest proportion of the compression of wages in Germany compared to the US. Adjusted for skill, the German distribution of wages remains more compressed than the American distribution. However, the skills of the German unemployed are too high for unemployment to be generated by the compressed wage structure and sufficiently higher than those of low skill Americans to raise doubts about inferring what might happen to German employment were Germany to increase the dispersion of pay to US levels.

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Appendix
The comparable German-American structural (CGAS) database

Comparability

We reclassified the German and US data into similar occupations and industries. The data have been made comparable over time (from 1970 to 1995) and between countries. This required aggregation to 64 comparable industries and 94 comparable occupations.

Data

The US are sub-samples from the 1970, 1980, and 1990 Census and the 1989 and 1995 CPS outgoing rotation group files. These data is available at individual level. Since we had for Germany only information on a detailed cell level but no strictly individual data, we aggregated the US data into comparable cells. For Germany access to data is difficult and except from small surveys (like the GSOEP) no information on hourly wages is available. Reliable income data is available from the Beschaeftigtenstatistik, which covers all employees subject to social security contributions but there is only limited information on hours worked. Hours worked are available from the Mikrozensus a 1% survey of the German population. We used the income information from the Beschaeftigtenstatistik and estimated wage functions (daily wage) for full-time workers (excluding apprentices) with the following explanatory variables: age (5-year age groups), education (eight groups), sex, occupation (94), and industry (64). The coefficients were used to estimate per day wages for the Mikrozensus sample. We estimated hours worked for similar cell definitions and used this to estimate hourly wages.