DOCUMENT RESUME

ED 394 000 CE 071 302

AUTHOR	Constantine, Jill M.; Neumark, David
TITLE	Training and the Growth of Wage Inequality. EQW Working Papers WP31.
INSTITUTION	National Center on the Educational Quality of the Workforce, Philadelphia, PA.
SPONS AGENCY	Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE	94
CONTRACT	R117Q00011-91
NOTE	31p.
PUB TYPE	Reports - Research/Technical (143)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Educational Opportunities; *Education Work Relationship; *Job Training; *On the Job Training; *Outcomes of Education; *Role of Education; *Salary Wage Differentials
IDENTIFIERS	Current Population Survey

ABSTRACT

The relationship between training and the growth in wage inequality was examined through an analysis of data from the January 1983 and January 1991 supplements to the Current Population Survey. The analysis focused on whether the distribution of training has changed in ways that may explain changes in the wage structure during the period studied and whether the changes in training, combined with the effects of training on wages, are sufficiently large to have induced the changes in wage structure observed during the 1980s. The shifts in the incidence in the various types of training offered during the 1980s were found to favor more educated, more experienced workers. When the observed shifts were considered in conjunction with the fact that training is associated with higher wages, it was concluded that training may have contributed to the growth of wage inequality during the 1980s. Further analysis established, however, that training did not play any substantial role in the increase in wage inequality observed during the 1980s. It was hypothesized that either the shifts in training distribution were too small or the returns on training were too low for training to have been a major factor in increased wage inequality. (Contains 18 references.) (MN)

EQW WORKING PAPERS

Training and the Growth of Wage Inequality

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"Training and the Growth of Wage Inequality" by Jill Constantine and David Neumark
EQW Catalog Number WP31

The work reported herein was supported by the Education Research and Development Center Program, agreement number R117Q00011-91, CFDA 84.117Q, as administered by the Office of Educational Research and Improvement, U.S. Department of Education. The findings and opinions expressed in this document do not reflect the position or policies of the Office of Educational Research and Improvement or the U.S. Department of Education.

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Acknowledgements

The authors thank Gus Faucher for assistance with some of the CPS calculations and Paul Swaim for helpful comments. The views expressed are the authors'.

Abstract

Shifts in the incidence of various types of training over the 1980s favored more educated, more experienced workers. Coupled with the fact that training is associated with higher wages, these shifts suggest training may have contributed to the growth of wage inequality in this period. However, the shifts were apparently too small, or the returns to training too low, for training to have played a substantial role in this increase. The estimated changes in wage differentials associated with schooling and experience are at best only slightly smaller once we account for changes in the distribution of training across schooling and experience groups, as well as changes in the returns to training and in the length of training programs.

Introduction

Wage inequality in the 1980s increased along two dimensions. First, there was an increase in "within-group" wage inequality, or wage inequality among workers with the same schooling, age, etc. This dimension of inequality trended upwards through the 1970s and 1980s, although more strongly so in the 1970s (Juhn et al. 1993). Second, there was an increase in "between-group" inequality—in the form of growing wage differentials between workers with different amounts of schooling or experience. The increases in schooling and experience differentials were the largest contributors to the overall growth of wage inequality in the 1980s (Juhn et al. 1993; Blackburn et al. 1990; Katz and Murphy 1992; Murphy and Welch 1992).

Existing research that seeks to explain these changes in the wage structure has focused primarily on the rise in between-group inequality.[1] Not surprisingly, economic research has emphasized demand and supply explanations.[2] This research generally concludes that demand shifts explain relatively more of the growth of wage inequality and, in particular, points to a shift in relative demand towards more skilled workers, probably driven by technological change (Bound and Johnson 1992; Berman, et al. 1993). Supply-based explanations have focused largely on the quantities of workers at different schooling levels. The "first-order" explanation based on supply changes does not fit the data, because the college-high school wage differential grew in the 1980s even though the relative supply of college-educated workers was higher in the 1980s than in the 1970s. However, the rate of growth of the college-educated workforce slowed in the 1980s, which, coupled with a steady growth of relative demand for more educated workers, could partially explain the rising college wage premium in this period (Blackburn et al. 1990; Katz and Murphy 1992).

While supply-based analyses of changes in the wage structure in the 1980s have focused on quantities (or changes in quantities) of workers at different schooling levels, another potential supply-side explanation is that the quality of workers at various schooling levels has changed. This possibility was first raised by Blackburn,

et al. (1990), who suggested that the relative ability of college- to high school-educated workers may have increased over the 1980s. However, the evidence is somewhat contradictory. Blackburn and Neumark (1993) find no evidence of a widening ability differential between schooling levels over this period, while Bishop (1991a) reports that the quality of college graduates relative to high school graduates increased over the 1980s.[3]

Explanations based on quality changes at different schooling levels have been criticized because they can at best provide a partial explanation for the increase in between-group wage inequality. The reason is that wage differentials by schooling level expanded not only for cohorts just entering the labor market, but for older cohorts as well, for whom the distribution of characteristics across schooling levels cannot have changed (Blackburn et al. 1990; Levy and Murnane 1992).[4]

However, the quality of a worker is not determined solely by schooling, and is not fixed at the completion of schooling. In particular, training—which is likely to increase a worker's productivity and wage—may occur at any point in his or her career (although theory suggests that it is more likely to occur at young ages). Our goal in this paper is to explore further whether quality changes in the workforce can explain changes in the wage structure over the 1980s. But rather than focus on school quality, we examine the role of changes in training. There are at least two empirical clues that motivate this question. First, Krueger (1993) provides evidence that changes in the incidence of computer use at work can explain a significant portion of the increase in the return to schooling from 1984 to 1989, partly because more educated workers are more likely to use computers at work. It seems likely that computer use on the job (especially when it is independent of computer use at home) is associated with training. Second, CPS tabulations suggest that increases in the incidence of training over the 1980s were more pronounced for more educated workers (Bureau of Labor Statistics 1992).

In our view, asking whether changes in the distribution of training across workers contributed to the growth of wage inequality in the 1980s is of interest for two reasons. First, changes in training may be an important part of a supply-side, quality-based explanation of changes in the wage structure, which can explain widening schooling/wage differentials for less experienced as well as more experienced workers.[5] Second, a stronger case could be made for efforts to expand training for lower wage workers if the relative (or absolute) wage declines they have experienced in the past decade can be attributed to relative (or absolute) declines in training.

The Data

We utilize data from the January 1983 and January 1991 supplements to the Current Population Survey (CPS). In both of these supplements, respondents were asked two questions regarding the incidence of training: "Did you need specific skills or training to obtain your current (last) job?" and "Since you obtained your present job, did you take any training to improve your skills?" Individuals responding affirmatively to either of these questions were then asked to list the sources of each type of training from a list including school, a formal company program, informal on-the-job training, and other types of training.[6] (Individuals could identify more than one source.) We focus on the set of training questions that are common to the 1983 and 1991 surveys. We are interested both in training to qualify for the current job and training to improve skills on the current job, since either type is likely to increase a worker's productivity. The first type of training is relatively more likely to be worker-financed, and the second employer-financed, although the information on financing is sparse and not common across the two surveys.[7,8] A response indicating that an individual received training in school to qualify for the current job is somewhat ambiguous, since he or she may simply be referring to regular schooling. Nonetheless, such information is potentially interesting because it indicates schooling that the worker perceives as directly related to the skills or qualifications for the current job.

While the questions were asked of all employed and unemployed persons, we are ultimately interested in looking at the relationship between training and wages and hence use data only on the outgoing rotation group (the members of which have wage data). In all cases, we report results using weighted data. The weights were constructed to represent the universe of non-self-employed individuals, aged 16 and over, who reported working for a wage in the survey week. The original sampling weights were adjusted to reflect that the population used in this study includes only those individuals who reported complete data on training, wages, schooling, and other variables used in the empirical analysis. The weights were adjusted separately by age

(five-year intervals for individuals under 25, ten-year intervals for all others), race, and sex. The empirical analysis focuses mainly on men, reflecting the emphasis in the literature on changes in their wage structure.

We use the hourly wage when it is reported; otherwise, the weekly wage is divided by usual weekly hours. The hourly wage is top-coded at $99 in both years, and we observe no top-coded hourly wages in our data. However, the weekly wage was top-coded at $999 in 1983, and $1923 in 1991. Because the $999 figure is often binding, this change in the top-coding may affect wage regression results, especially for more educated workers whose earnings are likely to be higher. We handle this by imposing on both years the lower of the two top-codes, measured in real dollars. Thus, we use a top-code in 1991 of $999 inflated to 1991 dollars using the PCE implicit price deflator, for a top-code of $1390. Once we have converted all wages to a nominal hourly wage with consistent top-codes, we express 1991 hourly wages in terms of 1983 dollars, again using the PCE implicit price deflator. This allows the estimated wage regression coefficients to be more easily interpreted as reflecting real wage changes or differentials.

Results

Changes in the Distribution of Training

The first question is whether the distribution of training has changed in ways that may explain changes in the wage structure. Some partial evidence on this question is provided in Bureau of Labor Statistics (1992), which documents an overall increase in training on the current job, and at the same time, sharper increases for more educated workers. In this section, we provide a more detailed analysis of this question. To assess whether changes in the distribution of training could have generated changes in schooling/wage differentials for more experienced as well as less experienced workers, we consider: (i) changes in each type of reported training, the number of types of training, and the length of formal company training, by schooling level; (ii) changes in training by level of potential experience; and (iii) changes in training by schooling level, within experience groups.[9]

Table 1 reports the incidence of training undertaken to qualify for the current job. The data are displayed in pairs of rows, the first row showing the proportion of

Table 1: Descriptive Statistics on Training to Qualify for Current Job, 1983 and 1991 CPS Samples, Men, By Schooling and Experience[1]

	Any training			Types of Training: Informal		Company		
	Present Job	*In-school*	*On the Job*	*Other*	*Training*	*1 type*	*2 types*	*3+ types*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
All workers								
1983	.55	.25	.30	.07	.12	.40	.12	.03
Change	*.01*	*.05*	*-.02*	*.01*	*.02*	*-.03*	*.01*	*.02*
By schooling								
Less than high school								
1983	.29	.03	.22	.05	.04	.25	.03	.01
Change	*-.01*	*.00*	*-.02*	*.02*	*.00*	*-.03*	*.02*	*.00*
High school graduate								
1983	.49	.11	.32	.08	.13	.38	.09	.02
Change	*-.02*	*.01*	*-.04*	*.00*	*.01*	*-.05*	*.01*	*.01*
Some college								
1983	.57	.23	.34	.10	.16	.38	.14	.05
Change	*.03*	*.08*	*-.03*	*-.01*	*.02*	*-.02*	*.01*	*.03*
College graduate or higher								
1983	.85	.69	.31	.06	.12	.58	.21	.06
Change	*-.02*	*.01*	*-.03*	*.03*	*.03*	*-.05*	*.00*	*.02*
By potential experience								
0-10								
1983	.49	.27	.24	.05	.08	.36	.10	.02
Change	*.02*	*.03*	*-.01*	*.02*	*.02*	*-.01*	*.03*	*.01*
10-20								
1983	.64	.32	.35	.08	.14	.45	.15	.05
Change	*-.04*	*.01*	*-.04*	*.00*	*.00*	*-.07*	*-.01*	*.01*
20+								
1983	.55	.20	.32	.08	.13	.40	.11	.03
Change	*.02*	*.08*	*-.04*	*.01*	*.01*	*-.03*	*.02*	*.02*

1. Estimates are based on 6994 observations in 1983, and 5825 observations in 1991. Estimates are based on weighted data. "Other" training is a combination of responses including training from correspondence courses, informal training from a friend, or other training.

respondents reporting such training in 1983 and the second showing the 1983-1991 change in the proportion. Across the columns, we first report the proportion indicating any type of training, followed by the proportions reporting each type of training, followed by the proportions reporting one, two, or three-or-more types of training.[10] The first row reveals that the proportion of respondents reporting any training to qualify for the current job was slightly greater than one-half (.55) and rose only slightly (by .01) over the sample period.[11] There were increases in the proportion reporting in-school training, formal company programs, and other training methods and a decrease in the proportion reporting informal on-the-job training. There were also increases in the proportions reporting either two or three-or-more types of training, and a decrease in the proportion reporting only one type of training.

Next, we look at these proportions disaggregated by schooling and potential experience. The first result to note is that the incidence of training rises sharply with schooling, with the proportion reporting any training needed to qualify for the current job rising from .29 (in 1983) for high school dropouts to .85 for those with a college degree or higher. However, looking at type of training—columns (2) through (5)—we see that this relationship is monotonically positive only for in-school training, so the result to some extent reflects the fact that higher levels of schooling are perceived as having qualified workers for their current jobs. With respect to potential experience, almost without exception each type of training to qualify for the current job exhibits an inverted U-shape, with the incidence of training higher for those with 10 to 20 years of potential experience than for those with less than 10 or more than 20 years of potential experience.

The question of interest, though, is whether disparities in training across schooling or experience groups widened between 1983 and 1991 in ways consistent with the widening of wage differentials by schooling or experience. In general, with respect to training to qualify for the current job, the answer appears to be no. For example, the proportion of respondents reporting any training fell by .01 for high school dropouts and .02 for college graduates and rose by .02 for workers with 0 to 10 years of experience as well as for those with more than 20 years of experience. Looking at the individual types of training by schooling level, the only finding consistent with the hypothesis that training contributes to widening wage differentials is that the proportion of college graduates reporting formal company training rose by .03—in contrast to a .01 rise for high school graduates and no change for high school dropouts. But for the other types of training, the changes in the incidence of training did not favor the more educated, with the exception of those with some college education who reported in-school training and those who reported three-or-more types of training. Similarly, looking at workers disaggregated by level of potential experience, there is no clear pattern of increases in the incidence of training in favor of more experienced workers, except for in-school training.

Table 2 turns to a similar analysis for training to improve skills on the current job. A number of differences compared with Table 1 are notable. First, not surprising given the different training question, a much smaller proportion report in-school training (.12 vs. .25 in 1983). Second, the relationship between schooling and training is more consistently positive, with the only exception to a positive monotonic relationship being informal on-the-job training for college graduates. More importantly, though, the evidence in favor of relative increases in training for more educated

Table 2: Descriptive Statistics on Training to Improve Skills on Current Job, 1983 and 1991 CPS Samples, Men, By Schooling and Experience[1]

	Any training			Types of Training: Informal		Company		
	Present Job	*In-school*	*On the Job*	*Other*	*Training*	*1 type*	*2 types*	*3+ types*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
All workers								
1983	.37	.12	.15	.04	.14	.31	.05	.01
Change	*.05*	*.01*	*.02*	*.02*	*.04*	*.00*	*.03*	*.01*
By schooling								
Less than high school								
1983	.18	.02	.12	.01	.04	.17	.01	.00
Change	*-.01*	*-.01*	*-.02*	*.00*	*.02*	*-.02*	*.01*	*.00*
High school graduate								
1983	.33	.06	.16	.03	.12	.29	.03	.01
Change	*.02*	*.02*	*.00*	*.01*	*.03*	*-.01*	*.02*	*.00*
Some college								
1983	.43	.16	.17	.03	.17	.35	.07	.01
Change	*.02*	*-.02*	*.02*	*.03*	*.04*	*-.03*	*.03*	*.02*
College graduate or higher								
1983	.55	.25	.14	.09	.22	.43	.09	.02
Change	*.08*	*.01*	*.05*	*.04*	*.06*	*.01*	*.04*	*.03*
By potential experience								
0-10								
1983	.33	.10	.15	.03	.11	.29	.04	.01
Change	*.02*	*.01*	*-.01*	*.01*	*.02*	*-.01*	*.01*	*.00*
10-20								
1983	.44	.15	.17	.05	.16	.37	.06	.01
Change	*.02*	*.00*	*.01*	*.03*	*.05*	*-.03*	*.03*	*.02*
20+								
1983	.36	.11	.14	.04	.15	.29	.05	.01
Change	*.07*	*.02*	*.03*	*.02*	*.05*	*.03*	*.03*	*.02*

[1] See footnotes to Table 1 for details. Here "other" training refers to a single response as distinct from the other categories indicated in the table.

and more experienced workers is quite pronounced. The proportion reporting any training fell by .01 for high school dropouts, rose by .02 for high school graduates, and rose by .08 for college graduates. A similar pattern of larger increases for college graduates appears for all types of training, with the exception of in-school training, and also appears in the form of increases in the proportion of respondents reporting two or more types of training. The same relative increase in training shows up for more experienced as compared with less experienced workers. For example, the proportion of respondents reporting any training rose by .07 for the most experienced group, compared with an increase of .02 for the least experienced group. A similar pattern of relative increases in training favoring the most experienced group (and sometimes also the group with 10 to 20 years of experience) is reflected for each type of training, and in the proportions reporting two or more types of training. Thus, the evidence in Table 2 is more suggestive of a role for training in generating the growth of between-group wage inequality over the sample period.

Part of the motivation for looking at training, as opposed to other supply-side, quality-based explanations of the rise in wage inequality, is the fact that schooling/wage differentials widened for more experienced as well as less experienced workers, as discussed in the introduction. It is therefore of interest to ask whether training can potentially explain this phenomenon as well. If training contributed to widening schooling/wage differentials for workers of all experience levels, the relative proportion reporting training should have risen among more educated workers, for those with both more and less experience. To examine this hypothesis, Table 3 reports changes in the proportion of respondents reporting training, disaggregated by schooling level, within experience groups. Panel A reports results for training to qualify for the current job, while Panel B reports results for training to improve skills on the current job. Looking first at training to qualify for the current job, there were in fact relative increases in formal company training, other training, and informal on-the-job training for college graduates as compared with other workers, although these relative increases show up only for the least experienced group. On the other hand, looking at training to improve skills on the current job (Panel B), relative increases in training for more educated workers are apparent for all experience groups, and, if anything, are sharper for workers with 10 to 20 or 20+ years of experience. For example, the proportion reporting any such training rose by .11 or .12 for college graduates with 10 or more years of potential experience, compared with essentially no change for less educated workers. Similar relative increases appear for each type of training—and to some extent for the proportions reporting multiple types of training. Therefore, it appears that training to improve skills on the current job, in particular, could have played a role in the observed changes in the wage structure.

The final dimension of the distribution of training that we examine is the length of training programs. Since the duration of training—and not just its incidence—is likely to affect wages, changes in the distribution of training based on its length could also have influenced wages.[12] In the CPS supplements, length of training is reported only for in-school training and formal company training and can be consistently coded across 1983 and 1991 only for the categories less than 13 weeks, 13 to 25 weeks, and 26 or more weeks. Because of the ambiguity regarding the interpretation of in-school training, we focus only on the length of formal company training programs. Table 4 reports changes in

Table 3: Descriptive Statistics on 1983-1991 Changes in Training By Schooling, Within Experience Group, 1983 and 1991 CPS Samples, Men[1]

A. Training to Qualify for Current Job

	Any training			Types of Training: Informal		Company		
	Present Job	*In-school*	*On the Job*	*Other*	*Training*	*1 type*	*2 types*	*3+ types*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Potential experience								
0-10								
Less than high school	-.02	.03	-.05	-.01	.00	-.03	.01	-.01
High school graduate	-.01	-.01	-.03	.01	.02	-.03	.01	-.01
Some college	.09	.08	-.01	.02	.02	.07	-.01	.01
College graduate or higher	.00	.00	.02	.08	.05	-.11	.06	.04
10-20								
Less than high school	-.02	.01	-.06	.00	-.02	-.02	.00	-.01
High school graduate	-.05	.01	-.02	.00	.01	-.12	.03	.02
Some college	-.01	.10	-.04	-.02	-.01	-.05	.01	.02
College graduate or higher	-.04	.02	-.06	.02	.01	-.01	-.05	.03
20+								
Less than high school	.00	-.01	-.01	.03	-.01	-.03	.02	.00
High school graduate	-.05	.02	-.10	.00	-.01	-.05	-.02	.00
Some college	-.05	.06	-.07	-.06	.02	-.10	-.02	.03
College graduate or higher	-.02	-.01	-.03	.02	.02	-.04	.00	.00

B. Training to Improve Skills on Current Job

Potential experience								
0-10								
Less than high school	.00	-.01	-.01	-.01	.05	-.03	.03	.00
High school graduate	.01	.01	-.01	.01	-.02	.01	-.01	.00
Some college	.01	.01	.02	.01	.01	-.02	.02	.02
College graduate or higher	.00	-.03	-.02	.0[illegible]	.06	-.01	.00	.01
10-20								
Less than high school	.03	-.01	-.01	.01	.03	.02	.00	.00
High school graduate	-.02	.04	-.04	.01	.01	-.06	.04	.01
Some college	.01	-.02	.02	.04	.04	-.05	.00	.04
College graduate or higher	.12	.01	.10	.06	.10	.01	.08	.03
20+								
Less than high school	-.02	-.01	-.03	.01	.01	-.03	.00	.00
High school graduate	.03	-.01	.03	.00	.03	.00	.02	.01
Some college	-.01	-.05	.03	.03	.02	-.05	.04	-.01
College graduate or higher	.11	.04	.08	.03	.04	.04	.03	.04

[1] See footnotes to Tables 1 and 2 for details. Only the changes in the proportion reporting training, from 1983 to 1991, are reported.

Table 4: Descriptive Statistics on Length of Training Programs for Those Receiving Training, 1983 and 1991 CPS Samples, Men[1]

	Formal company training to qualify for current job			Formal company training to improve skills on current job		
	<13 weeks	*13-25 weeks*	*26+ weeks*	*<13 weeks*	*13-25 weeks*	*26+ weeks*
	(1)	(2)	(3)	(4)	(5)	(6)
All workers						
1983	.47	.12	.41	.75	.09	.16
Change	*.05*	*-.01*	*-.04*	*.01*	*.00*	*.00*
By schooling						
Less than high school						
1983	.43	.11	.46	.85	.11	.05
Change	*.08*	*-.02*	*-.06*	*-.18*	*-.05*	*.23*
High school graduate						
1983	.49	.10	.40	.74	.11	.15
Change	*.08*	*-.01*	*-.06*	*.04*	*-.04*	*.00*
Some college						
1983	.46	.14	.40	.76	.08	.16
Change	*.01*	*-.02*	*.01*	*-.05*	*.01*	*.03*
College graduate or higher						
1983	.46	.13	.41	.74	.07	.18
Change	*.03*	*.00*	*-.03*	*.03*	*.03*	*-.06*
By potential experience						
0-10						
1983	.46	.16	.38	.78	.06	.17
Change	*.15*	*-.08*	*-.07*	*.01*	*.02*	*-.04*
10-20						
1983	.49	.11	.40	.74	.09	.17
Change	*.04*	*.02*	*-.06*	*.04*	*-.02*	*-.03*
20+						
1983	.47	.11	.42	.75	.10	.15
Change	*.00*	*.00*	*-.01*	*-.02*	*.00*	*.02*

[1] See footnotes to Tables 1 and 2 for details.

the distribution of training by length, for those reporting a formal company training program. The first three columns refer to training to qualify for the current job. The estimates reveal relative increases in the length of training for more educated and more experienced workers. The proportion receiving training lasting less than 13 weeks rose by .08 for high school graduates and dropouts but only by .03 for college graduates or those with some college. In contrast, the proportion receiving training lasting 26 weeks or longer fell by .06 for high school graduates and dropouts, but fell by only .03 for college graduates. Similarly, the distribution of lengths of training programs shifted towards programs lasting less than 13 weeks for workers with 0 to 10 years of potential experience and 10 to 20 years of potential experience (although less so for the latter group), while there was no change in the distribution for the most experienced workers.

The results for training to improve skills on the current job, reported in columns (4) through (6), are more ambiguous. Disaggregated by experience group, the results parallel those for training to qualify for the current job, although the changes are less sharp. But by schooling level, the results are reversed; high school dropouts show the largest decrease in the proportion of respondents receiving training lasting less than 13 weeks and the largest increase in the proportion of respondents receiving training lasting 26 weeks or more. Thus, the overall evidence from the data on length of training is ambiguous, with only some of the evidence pointing towards increased length of training for more educated or more experienced workers.

Changes in Wage Inequality

Thus far, the evidence on changes in the distribution of training is potentially consistent with the notion that changes in training contributed to the growth of wage inequality in the 1980s. However, the key question is whether the changes themselves, combined with the effects of training on wages, are sufficiently large to have induced the observed changes in the wage structure. In this section we turn to evidence that answers this question.

Our strategy consists of first estimating a standard log wage regression that captures the increase in between-group wage inequality in the 1980s,[13] by adding interactions of a year dummy variable with both schooling and experience, as in $\ln(w_i) = \alpha + S_i\beta + S_i \cdot D91_i\beta' + \gamma \cdot E_i + \gamma' \cdot E_i \cdot D91_i + \delta \cdot D91_i + Z_i\pi + \varepsilon_i$, where ln(w) is the log hourly wage, S is a set of schooling dummy variables, E is potential experience, D91 is a dummy variable for 1991, and Z is a matrix of other control variables described in the footnotes to Table 5. High school graduates are the omitted reference category, so δ measures the real wage change for high school graduates from 1983 to 1991, and the coefficients in the vector β' measure real wage changes of other schooling groups relative to high school graduates. We then add to the wage equation controls for training and ask whether the changes in the wage structure captured in β' and γ' are reduced once we hold the distribution of training constant.

An obvious question is whether any positive association between wages and training that we detect represents a causal effect of training, rather than the appearance of heterogeneity bias because individuals with higher wages receive more training. In our view, the literature on the returns to training establishes that individuals (higher- as well as lower-skilled workers) experience faster wage growth during periods of training than at other times (Brown 1989; Bishop 1991b; Lynch 1988; Holzer 1990; Mincer 1989).

Table 5 reports our results.[14] The first column shows estimates of the wage equation described above. The estimates reflect the current, well established changes in the wage structure. In particular, real wages of high school dropouts relative to high school graduates declined by 6.3 percent from 1983 to 1991, and real wages of college graduates relative to high school graduates rose by 10.2 percent. The return to experience rose by about .002 per year of experience, resulting in experience-wage differentials that are wider by 2 percent for every 10 years of experience.

Column (2) adds controls for the incidence of training to improve skills on the present job. Because dummy variables are included for each type of training, information on the number of types of training is also captured. All four types of training are significantly associated with higher wages, with the largest estimates for other training and formal company training (.119 and .188 respectively). Of course, the effect of in-school training may partly reflect the usual schooling effect, which may explain why the estimated returns to some college and college graduation both fall somewhat relative to column (1). Most importantly, though, the changes in the wage structure from 1983 to 1991 are moderated only slightly, if at all. The real wage decline of high school dropouts is now 6 percent, and the estimated growth of the experience premium is essentially unchanged. The estimated rise in the college graduate-high school graduate differential falls from .102 to .089, a drop of 12 percent.

A similar analysis is provided in column (3), but with the addition of dummy variables for training to qualify for the current job. Again, the estimated coefficients of the training dummy variables are positive and significant, with the exception of other training. Also, presumably because in-school training to qualify for the job overlaps strongly with college education, the estimated coefficient of the college graduate dummy variable falls to .243. The inclusion of these additional training variables has no further effect on the estimated schooling-wage or experience-wage differentials. If anything, the estimated increase in the college graduate high school graduate wage differential rise slightly to .092.

Next, we extend the analysis in two ways. First, we allow for the possibility that the returns to training increased over the sample period. This seems likely to have happened if, as argued by Juhn et al. (1993), the overall price of skill has risen. If the returns to training have increased, then the effect of increases in training for more educated or more experienced workers may be understated in the estimates in columns (2) and (3) of Table 5. Column (4) reports estimates from a specification adding interactions of all of the training variables with the dummy variable for 1991. It turns out that there is no evidence of increases in the returns to any type of training. In fact, as the table reports, the only significant (at the ten-percent level) changes in the estimated coefficients of the training variables are declines from 1983 to 1991. More to the point, this augmentation of the specification has some offsetting influences on the estimated changes in schooling/wage or experience/wage differentials. The estimated increase in the high school graduate/high school dropout differential, and in the experience/wage differential, rise slightly, while the estimated change in the college graduate/high school graduate differential falls to 8.3 percent.

Second, we allow for the possibility that the returns to training vary for workers with different amounts of schooling. If they do, then the estimates in columns (2) and (3) may also not fully reflect the influence of

Table 5: Log Wage Equation Estimates Incorporating Training, 1983 and 1991 CPS Samples, Men[1]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1991	-.017	-.021	-.022	.005	-.024	-.020	-.022
	(.018)	(.018)	(.017)	(.019)	(.017)	(.018)	(.018)
High school drop out	-.220	-.202	-.183	-.178	-.184	-.215	-.181
	(.017)	(.017)	(.017)	(.017)	(.019)	(.017)	(.017)
_ 1991	-.063	-.060	-.061	-.069	-.061	-.061	-.060
	(.023)	(.023)	(.023)	(.023)	(.023)	(.024)	(.023)
Some college	.121	.101	.084	.081	.109	.123	.085
	(.017)	(.017)	(.017)	(.017)	(.020)	(.018)	(.017)
_ 1991	.023	.020	.008	.010	.010	.024	.011
	(.022)	(.022)	(.022)	(.022)	(.022)	(.023)	(.022)
College graduate or higher	.355	.316	.243	.247	.256	.353	.237
	(.016)	(.016)	(.017)	(.019)	(.021)	(.016)	(.017)
_ 1991	.102	.089	.092	.083	.098	.111	.102
	(.021)	(.021)	(.020)	(.024)	(.020)	(.021)	(.021)
Potential experience[2]	.069	.067	.064	.063	.065	.068	.063
	(.004)	(.004)	(.004)	(.004)	(.004)	(.004)	(.004)
_ 1991	.0018	.0017	.0019	.0020	.0020	.0017	.0018
	(.0006)	(.0006)	(.0006)	(.0006)	(.0006)	(.0006)	(.0006)
Training to improve skills in present job							
In-school	...	.088	.039	.072	.080	...	.047
		(.012)	(.013)	(.020)	(.026)		(.013)
Informal on the job	...	.038	.028	.048	.066	...	.033
		(.011)	(.011)	(.017)	(.017)		(.011)
Other	...	.119	.088	.062	.072	...	.099
		(.018)	(.018)	(.031)	(.036)		(.018)
Formal company	...	.188	.148	.147	.151	...	.140
		(.011)	(.011)	(.018)	(.020)		(.013)
Training to qualify for present job							
In-school	...	...	.154	.141	.088	...	.157
			(.011)	(.017)	(.021)		(.011)

Table 5 continued: Log Wage Equation Estimates Incorporating Training, 1983 and 1991 CPS Samples, Men[1]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Informal on the job	...	...	.068 (.009)	.119 (.013)	.093 (.014)	...	.074 (.009)
Other	...	...	.009 (.015)	.006 (.023)	.022 (.024)	...	.005 (.015)
Formal company	...	...	.109 (.012)	.103 (.019)	.161 (.019)	...	.081 (.018)
Other controls included, significant estimates (p=.1)3							
Interactions of training variables with 1991 dummy	No	No	No	Yes	No	No	No
Schooling to improve skills _ 1991	...	...	...	-.056 (.025)	...	...	...
Informal on the job to qualify _ 1991	...	...	...	-.091 (.018)	...	...	...
Interactions of training variables with schooling dummies[4]	No	No	No	No	Yes	No	No
College graduate _ schooling to improve skills	...	...	...	...	-.094 (.031)	...	...
Some college _ informal on the job to improve skills	...	...	...	...	-.059 (.028)	...	...
College graduate _ informal on the job to improve skills	...	...	...	...	-.078 (.027)	...	...
Less than high school _ formal company to improve skills	...	...	...	...	.094 (.047)	...	...
College graduate _ schooling to qualify	...	...	...	...	.131 (.027)	...	...
College graduate _ informal on the job to qualify	...	...	...	...	-.054 (.022)	...	...

Table 5 continued: Log Wage Equation Estimates Incorporating Training, 1983 and 1991 CPS Samples, Men[1]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Some college _ formal company to qualify	...	...	...	...	-.059 (.031)	...	...
College graduate _ formal company to qualify	...	...	...	...	-.127 (.030)	...	...
Subsample with length of training data[5]	No	No	No	No	No	Yes	Yes
Length of formal company training programs	No	No	No	No	No	No	Yes
Formal company to qualify _ 26+ weeks	...	...	...	...	...	...	.067 (.027)
Formal company to improve skills _ 26+ weeks	...	...	...	...	...	...	.072 (.029)
$\bar{R}^2$	.388	.408	.424	.426	.428	.389	.425

1. Dependent variable is the log of the nominal hourly wage, deflated by the PCE deflator. For the schooling variables, high school graduate is the omitted reference category. Other control variables included are: dummy variables for married, spouse present, residence in the south and in urban areas, and black. Estimates are based on 6994 observations in 1983, and 5825 observations in 1991. Estimates are based on weighted data. See footnotes to Tables 1 and 2 for more details.

2. Quadratic, cubic, and quartic terms are also included.

3. In all cases, the full set of control variables is added to the regression, but only the statistically significant estimates are reported.

4. Interactions with high school graduate are omitted, so training variables continue to measure effects for this group.

5. See Table 4 for definitions of variables. Because of missing data, estimates in columns (6) and (7) are based on 6851 observations in 1983, and 5516 observations in 1991.

training on the wage structure. Column (5) reports estimates from a specification adding interactions of all of the schooling variables with all of the training variables. The estimated coefficients of these interactions are perhaps of some interest. The subset that are statistically significant (at the ten-percent level) are reported in the table and tend to reveal lower returns to informal and formal training for college graduates and those with some college and higher returns to formal training for high school dropouts. With respect to the principal question at hand, adding these interactions to some extent lessens our ability to explain the changes in the wage structure, since the relative increases in training for more educated workers now contribute less to their wage growth. In particular, the estimated increase in the college graduate/high school graduate wage differential rises to 9.8 percent, scarcely below the original 10.2 percent increase in column (1).

Finally, we explore the consequences of also including information on the length of formal company training programs, using the data described in reference to Table 4. Because of missing data on the length of training, a slightly smaller sample is available for this specification, so we first—in column (6)—report estimates of the same specification as in column (1) for this subsample. In column (7), we add the length of training variables. The estimated coefficients of these variables are reasonable, indicating that the longest training programs (26 or more weeks) are associated with wages that are higher by about seven percent. Comparing columns (6) and (7) shows that the effects of adding the training controls are similar to the previous specifications. The training variables account for virtually none of the increase in the high school graduate/high school dropout wage differential or the experience/wage differential, and they account for less than 10 percent of the estimated increase in the college graduate/high school graduate wage differential.

Sensitivity Analysis

Table 6 reports some sensitivity analyses of the results for changes in schooling wage differentials. First, columns (1) through (6) report results disaggregated by potential experience. The changes in the wage structure by schooling level vary across the experience groups. As discussed above, the rise in the college graduate high school graduate wage differential is sharpest for those with 0-10 years of experience. In fact, in these data, the rise is not statistically significant for those with more than 20 years of experience. On the other hand, only for those with more than 20 years of experience did the high school graduate high school dropout wage gap widen between 1983 and 1991. Thus, it is only the college graduate high school dropout wage differential that widened consistently across the three experience groups.[15] At the same time, as for the aggregated regressions reported in Table 5, the addition of the training variables does little to explain the changes in wage differentials associated with schooling.

Column (7) reports results for the full sample when the training variables are added, except for in-school training, which may be difficult to distinguish from schooling. The estimates should be compared with those in column (3) of Table 5. Omitting in-school training has very little effect on the estimates. For example, the estimated increase in the college graduate/high school graduate wage differential is .090, compared with .092 when in-school training is included. Columns (8) and (9) add a quartic in tenure to the wage equation specifications estimated by both accounting and not accounting for training. Again, the results are qualitatively very similar, in that the training variables

Table 6: Sensitivity Analysis of Log Wage Equation Estimates Incorporating Training, 1983 and 1991 CPS Samples, Men[1]

	Pot. Exp. 0-10[2]		Pot. Exp. 10-20[3]		Pot. Exp. 29+[4]		Without In-School Training	With Tenure Quartic[5]		Linear Schooling[6]	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1991	-.088	-.078	.072	.023	.008	-.005	-.019	-.014	-.019	-.025	-.033
	(.035)	(.034)	(.081)	(.078)	(.054)	(.052)	(.018)	(.017)	(.017)	(.015)	(.015)
High school drop out	-.202	-.184	-.338	-.293	-.173	-.128	-.192	-.192	-.161	...	...
	(.028)	(.027)	(.039)	(.038)	(.027)	(.026)	(.017)	(.017)	(.016)		
_ 1991	.004	-.004	.046	.049	-.130	-.127	-.063	-.057	-.058	...	...
	(.041)	(.040)	(.051)	(.049)	(.036)	(.035)	(.023)	(.023)	(.022)		
Some college	.111	.084	.087	.051	.168	.118	.105	.120	.089	...	...
	(.024)	(.024)	(.032)	(.031)	(.033)	(.032)	(.017)	(.017)	(.016)		
_ 1991	.027	.009	.087	.074	-.032	-.041	.017	.020	.006	...	...
	(.035)	(.034)	(.040)	(.039)	(.040)	(.039)	(.022)	(.022)	(.021)		
College graduate or higher	.378	.256	.317	.225	.366	.255	.337	.340	.243	...	...
	(.024)	(.025)	(.029)	(.030)	(.030)	(.032)	(.016)	(.016)	(.016)		
_ 1991	.143	.130	.129	.114	.066	.053	.090	.089	.082	...	...
	(.034)	(.033)	(.037)	(.036)	(.037)	(.036)	(.021)	(.020)	(.020)		
Years of schooling	...	...	...	...	...	...	...	...	...	.068	.051
										(.002)	(.002)
_ 1991	...	...	...	...	...	...	...	...	...	.022	.019
										(.003)	(.003)
Includes variables for training to qualify and training to improve skills	No	Yes	No	Yes	No	Yes	Yes	No	Yes	No	Yes
$\bar{R}^2$	.437	.463	.278	.321	.283	.330	.413	.428	.457	.394	.430

1. With the exceptions noted, specifications are the same as in column (3) of Table 5.
2. Sample size is 3792.
3. Sample size is 3628.
4. Sample size is 5399.
5. Linear, quadratic, cubic, and quartic terms are added.
6. Schooling is transformed by subtracting off 12, so the 1991 dummy variable continues to measure the real wage of high school graduates in 1991 relative to 1983.

account for little or none of the changes in schooling/wage differentials.

Finally, columns (10) and (11) report estimates of the basic specifications substituting linear years of schooling completed for the set of dummy variables. As shown above, only a small proportion of the increase in the return to schooling is explained by adding the training variables. The increase in the return to a year of schooling from 1983 to 1991 falls from .022, omitting the training variables, to .019 including them, so that the inclusion of the training variables "explains" 14 percent of the increase in the return to schooling.

The Role of Computers

As discussed above, part of the motivation for looking at the role of training in generating the increase in wage inequality was the finding that computer use at work partly accounts for this increase (Krueger 1993), along with the presumption that computer use at work is closely linked to training. The 1991 January supplement includes two questions relating to computers that are useful in exploring the relationship between training, computers, and wages. First, individuals indicate whether their training to improve skills on the current job included computer skills. Second, individuals are asked whether they use PCs or computer terminals at work (to which they can respond "never", "less than once a week", "one or more times per week", or "every day").

Table 7 provides some evidence documenting the linkages between training, computer training, and computer use.[16] The first row contains the proportion of those reporting each type of training to improve skills on their current job who also report that the training taught computer skills. The numbers reveal that, depending on the type of training, between 25 and 43 percent of workers who report training learned computer skills. The next four rows report on the relationship between computer use at work and training to improve skills. The numbers show that, on the one hand, about one-quarter to one-third of those who received training never use a computer at work. On the other hand, over one-half of those in each training category who received training use a computer every day. This shows that training is frequently associated with intensive computer use. In addition, workers who do not receive training are less likely to use computers at work, as the last column reveals. Compared to workers who received training, workers who did not receive training are twice as likely to report never using a computer at work (62 percent vs. 31 percent), and just over one-half as likely to report using a computer every day (29 percent vs. 54 percent). Finally, as these results suggest, computer use at work is related to computer training. This is shown in the last row of the table, which contains the proportion reporting computer-related training, classified by computer use at work. Virtually no workers (2 percent) of those with computer-related training report that they never use a computer at work, whereas 29 percent of those who use a computer every day report computer-related training.

The figures in Table 7 relating training to computer use at work suggest that our findings regarding the role of training in generating changes in the wage structure ought to closely parallel Krueger's (1993) findings regarding the role of computer use at work in generating these changes. However, our finding that changes in training explain relatively little of the increase in the return to schooling contrasts with Krueger's conclusion that "the proliferation of computers can account for between one-third and one-half of the increase in the rate or return to education observed between 1984 and 1989" (1993, 55).

Table 7: Training to Improve Skills on Current Job, Computer Training to Improve Skills on Current Job, and Computer Use at Work, 1991 CPS Sample, Men and Women[1]

	Any Training Present Job	In-School	Informal On the Job	Other	Company Training	No Training
Proportion reporting training in computer-related skills	.33	.43	.35	.25	.41	.00
Proportion reporting use of a PC or computer terminal:						
Never	.31	.25	.35	.29	.24	.62
Less than once per week	.06	.06	.05	.08	.06	.04
One or more times per week	.09	.13	.08	.13	.08	.06
Every day	.54	.56	.51	.51	.61	.29

	Uses computer Never uses computer	Uses computer less than once per week	one or more times per week	Uses computer every day	
Proportion reporting training in computer-related skills		.02	.12	.19	.29

1. Based on weighted data for men and women in 1991. There are 11812 observations. although for the questions on computer use at work, there were 134 non-responses.

There appear to be two differences that underlie the results. First, the estimated increase in the return to schooling—before accounting for training or computer use—is much smaller in Krueger's paper than in ours. His initial estimate of the increase in the return to schooling in Table VII, columns (1) and (4), is .01, whereas our estimate in Table 6, column (7), is .022. In fact, his incorporation of computer use accounts for an increase of .004 in the return to schooling in Table VII, columns (2) and (5), whereas our incorporation of training accounts for an increase of .003 in Table 6. Thus, much of the difference comes from the fact that Krueger explains a greater *relative* amount of the increase in the return to schooling, because he starts out with a much smaller increase.

Second, while Table 7 documents strong relationships between training—specifically computer-related training—and computer use at work, the table also shows that there are sizable fractions of workers who use computers at work but do not report computer-related training or any training.[17] Therefore, some of the increased use of computers at work may be independent of training, at least insofar as we can measure such training. In addition, Table 7 demonstrates that there is a good deal of training unrelated to computers, which may have different effects on wages than computer-related training. Thus, general information on training may not capture the full effects on the wage structure of the spread of computers, because computer use at work that is independent of training may raise wages and because the returns to computer-related training may be higher than returns to other training.

Table 8 presents evidence on these questions. To provide results more comparable to Krueger's, we estimate specifications much more similar to his. We include women in the sample and add a dummy variable for the category female and an interaction between this dummy variable and marital status to the wage equations. We also report results using linear years of schooling, as Krueger does.[18] The estimates in columns (1) and (2) show that the estimated return to schooling increased from .070 to .095, for an increase of .025, which is slightly larger than the increase in Table 6 for men only (.022). Changes in training, found in columns (3) and (4), accounts for .005 of this increase, implying that training "explains" 20 percent of the increase in the return to schooling—similar to the estimate for men in columns (10) and (11) of Table 6. In these estimates, as well, the increase in the return to schooling accounted for by changes in training (.005) is similar to Krueger's estimate of the increase accounted for by the proliferation of computers (.004). Again, though, the overall increase in the return to schooling is larger in our analysis.[19]

Columns (5) through (7) explore the effects on wages of computer-related training and computer use at work for 1991. Column (5) adds a dummy variable indicating whether the reported training was computer-related. The estimated coefficient of the computer-related training dummy is positive (.019) but insignificant, thus failing to provide evidence that computer-related training has higher returns than other training. On the other hand, the estimates in column (6) show that computer use at work, even controlling for training, is associated with significantly higher wages, with effects of a similar magnitude to those reported by Krueger.[20] Finally, in column (7) we add interactions between the computer use and computer-training variables to check whether the returns to computer-related training are higher for those who use computer at work (or, alternatively, whether the returns to computer use at work are higher for those who receive computer-related training). In

Table 8: Log Wage Equation Estimates Incorporating Training, 1983 and 1991 CPS Samples, Men and Women[1]

	1983 (1)	1991 (2)	1983 (3)	1991 (4)	1991 (5)	1991 (6)	1991 (7)
Years of schooling completed	.070 (.001)	.095 (.002)	.050 (.002)	.070 (.002)	070 (.002)	.052 (.002)	.061 (.002)
Includes controls for training to improve skills on present job, training to qualify for present job, and length of formal company training	No	No	Yes	Yes	Yes	Yes	Yes
Computer-related training	...	...	...	...	.019 (.014)	-.050 (.014)	.014 (.041)
Computer use at work							
Less than once per week	...	...	...	...	...	.112 (.020)	.104 (.021)
_ computer-related training	...	...	...	...	...	...	.026 (.071)
Once or more times per week	...	...	...	...	...	.120 (.017)	.119 (.018)
_ computer-related training	...	...	...	...	...	...	-.048 (.056)
Every day	...	...	...	...	...	.207 (.010)	.213 (.010)
_ computer-related training	...	...	...	...	...	...	-.080 (.043)
$\bar{R}^2$	.370	.398	.414	.448	.448	.469	.469

1. Dependent variable is the log of the hourly wage. For the schooling variables, high school graduate is the omitted reference category. Other control variables included are: dummy variables for married, spouse present, residence in the south and in urban areas, female, and black, potential experience and its square, and an interaction between female and marital status. Estimates are based on 13035 observations in 1983, and 11289 observations in 1991. Estimates are based on weighted data. See footnotes to Tables 1 and 2 for more details.

Table 9: Log Wage Equation Estimates Incorporating Computer Training and Computer Use at Work, 1991 CPS Sample, Men and Women[1]

	1983 (1)	1991 (2)	1983 (3)	1991 (4)	1983 (5)	1991 (6)	1983 (7)	1991 (8)
Years of schooling completed	.089	.068	.078	.061	.077	.061	.077	.060
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
Training variables included[2]	No	Yes	No	Yes	No	Yes	No	Yes
Computer training to improve skills in present job	.15	.02	...	...	.06	-.05	.14	.02
			(.01)	(.01)	(.01)	(.01)	(.04)	(.04)
Dummy variables for uses PC or computer terminal:								
Less than once per week	...	...	.17	.11	.16	.12	.16	.11
			(.02)	(.02)	(.02)	(.02)	(.02)	(.02)
One or more times per week	...	...	.17	.12	.16	.12	.17	.12
			(.02)	(.02)	(.02)	(.02)	(.02)	(.02)
Every day	...	...	.26	.20	.24	.21	.25	.21
			(.01)	(.01)	(.01)	(.01)	(.01)	(.01)
Interactions between computer training to improve skills and computer use:								
Less than once per week	...	...	...	...	...	...	-.02	.02
							(.07)	(.07)
One or more times per week	...	...	...	...	...	...	-.08	-.05
							(.06)	(.06)
Every day	...	...	...	...	...	...	-.09	-.08
							(.05)	(.04)
$\bar{R}^2$	.40	.45	.43	.47	.44	.47	.44	.47

[1] Dependent variable is the log of the hourly wage. Specifications are the same as in Table 8, except for the inclusion of the computer variables. Estimates are based on 11167. Estimates are based on weighted data. See footnotes to Tables 1, 2, and 8 for more details.
[2] This refers to the dummy variables for training programs and their length, used in Table 8.

fact, two of the estimated coefficients of these interactions are negative although insignificant, and the results suggest that, if anything, those who use computers at work and received computer-related training earn lower wages. This may reflect greater firm specificity of computer skills that were obtained via training on the current job. At any rate, the results continue to suggest that there are significant wage differentials associated with computer use at work, independent of training.

Thus, the proliferating use of computers is likely to have contributed to the growth in between-group wage inequality independently of the impact of changes in training. In addition, the results suggest that computer-related training on the job is unlikely to confer on workers all of the gains associated with computer use at work. Rather, the wage differentials associated with computer use at work reflect, at least in part, other factors such as computer skills learned in school, or on previous jobs, or worker heterogeneity.

Conclusion

Shifts in the incidence of various types of training over the 1980s favored more educated, more experienced workers. Coupled with the fact that this training is associated with higher wages, these shifts suggest that training may have contributed to the growth of wage inequality in this period. However, the shifts were apparently too small, or the returns to training too low, for training to have played a substantial role in this increase. The estimated changes in wage differentials associated with schooling and experience are generally only slightly smaller once we account for changes in the distribution of training across schooling and experience groups, as well as for changes in the returns to training and changes in the length of training programs.

None of this is intended to say that training does not boost wages. There may be long-term reasons for the lower incidence of training among less educated, lower wage workers, which may or may not be amenable to policy intervention. However, in policy debates regarding approaches to increasing the absolute or relative pay of less educated and younger workers, it is important to understand that the real wage stagnation or declines that such workers have faced in the past decade apparently did not stem from a sharp drop-off in either self-financed or employer-financed training.

Endnotes

[1] Blackburn and Neumark (1993) provide some evidence on potential explanations of increased within-group inequality, in particular whether the price of ability has risen, as conjectured by Juhn, et al. (1993).

[2] There is also research on institutional changes regarding minimum wages and union organization (Blackburn et al. 1990), and the changing composition of jobs in the U.S. economy (Bluestone and Harrison 1986).

[3] In related research, Cameron and Heckman (1993) show that over the 1980s an increasing proportion of high school graduates held GEDs, and that the returns to such degrees are lower than the returns to a high school diploma.

[4] In principle, such changes could arise through selection into employment. But this seems implausible for prime-age males, who have employment rates exceeding 90 percent.

[5] Of course, such changes cannot be viewed as entirely distinct from demand-side changes, since changes in the demands for skills may spur training.

[6] More details are provided in U.S. Department of Labor (1992).

[7] In the 1983 survey respondents were asked if their in-school and formal company training was paid for by their employer. In the 1991 supplement, respondents were asked if their employers paid for all, half or more, less than half, or none of their in-school training only.

[8] Studies that have tested whether workers or employers pay for general and specific training have shown that although most employers and workers consider the training they receive to be fairly general, employers appear to pay for a large portion of training (Baron, Berger, and Black 1993; Bishop 1990).

[9] Throughout this subsection, we do not report the statistical significance of the differences in training that we discuss, since we are less interested in these differences per se than in the effects of these differences on the wage structure.

[10] The proportions reporting four or more types of training were minuscule, so we combine those reporting three and four or more types.

[11] In Bureau of Labor Statistics (1992) this proportion is reported to rise from .55 to .57, although the sample is different (most importantly, perhaps, including women).

[12] Studies by Mincer (1989) and Barron, Berger, and Black (1993) have found that intensity as well as incidence of training have positive effects on wage growth.

[13] We originally intended to consider within-group inequality as well. However, it turns out that in these data within-group wage inequality did not increase from 1983 to 1991 and, if anything, fell slightly. Overall wage inequality did increase. The difference between the 50th and 10th percentile of log wages rose from .79 to .81 from 1983 to 1991, while the 90th-50th difference rose from .66 to .70. However, looking at the residuals from the first regression reported in Table 5, the 50th-10th difference was the same (.57) in 1983 and 1991, and the 90th-50th difference fell from .51 to .50.

[14] Throughout the wage equation analysis, we ignore issues of selection into employment and endogeneity of training. These are potentially important issues, but we do not believe that the CPS offers data on exogenous determinants of employment or training that can be convincingly excluded from the wage equation.

[15] This is not at odds with other findings reported in the literature. For example, Blackburn et al. (1990, 37) report that the college graduate/high school graduate wage gap widened by 13 percent for workers aged 25 to 64 from 1980 to 1988, but only by 8 percent for workers aged 25 to 34. On the other hand, the college graduate/high school dropout wage gap widened by 16 percent for workers aged 25 to 64, but by 20 percent for workers aged 25 to 34.

[16] For comparability with the regression estimates that follow, these tabulations are reported for men and women.

[17] For example, the last number in the last row of the table implies that 71 percent of those using computers every day did not report computer-related training.

[18] The only difference in the specifications is that we omit controls for union membership (which is unavailable in the January 1983 CPS), veteran, and part-time status. Also, as dictated by the CPS supplements, his regressions cover 1984 and 1989, whereas ours cover 1983 and 1991.

[19] To better assess the change in the return to schooling over these periods, we estimated the specifications in columns (1) and (2) of Table 8 for 1983, 1984, 1989, and 1991 using the outgoing rotation group annual files of the CPS. Because we are interested in the 1984-1989 and the 1983-1991 changes in the estimated return to schooling, we handled the top-coded weekly earnings figures by inflating the $999 top-code in 1984 (1983) to the same real value in 1989 (1991), again using the PCE implicit price deflator. We used the same exclusion restrictions used for the sample drawn from the January supplements. In these estimates, the return to schooling rose by .009 (.075 to .084) from 1984 to 1989 and by .016 (.072 to .088) from 1983 to 1991. Thus, the return appears to have grown more over the longer period, although not by as much as indicated in our January CPS data.

[20] The negative estimated coefficient for the computer-related training variable in this specification may not be entirely surprising, since it measures the wage differential for those who received such training, but who do not use computers at work.

References

Barron, John, Mark Berger, and Dan Black. 1993. "Do Workers Pay for On-The-Job Training?" University of Kentucky Business School Working Paper No. E-1169-93.

Berman, Eli, John Bound, and Zvi Griliches. 1993. "Changes in the Demand for Skilled Labor Within U.S. Manufacturing Industries: Evidence from the Annual Survey of Manufacturing." NBER Working Paper No. 4255.

Bishop, John H. 1991a. "Achievement, Test Scores, and Relative Wages." In Marvin H. Kosters, Ed., *Workers and Their Wages: Changing Patterns in the United States*. Washington, D.C.: The AEI Press, pp. 146-86.

_____. 1991b. "On-The-Job Training of New Hires." In D. Stern and J. M. Ritzen, Eds., *Market Failure in Training?* Berlin: Springer-Verlag, pp. 61-98.

Blackburn, McKinley L., David E. Bloom, and Richard B. Freeman. 1990. "The Declining Economic Position of Less Skilled American Men." In Gary Burtless, Ed., *A Future of Lousy Jobs? The Changing Structure of U.S. Wages*. Washington, D.C.: The Brookings Institution, pp. 31-67.

Blackburn, McKinley L., and David Neumark. 1993. "Omitted-Ability Bias and the Increase in the Return to Schooling." *Journal of Labor Economics* 11(3):521-44.

Bound, John, and George Johnson. 1992. "Changes in the Structure of Wages in the 1980s: An Evaluation of Alternative Explanations." *American Economic Review* 82(3):371-92.

Brown, James. 1989. "Why Do Wages Increase with Tenure?" *American Economic Review* 79(5):971-992.

Bureau of Labor Statistics. 1992. "How Workers Get Their Training: A 1991 Update." Bulletin 2407.

Cameron, Stephen V., and James J. Heckman. 1993. "The Nonequivalence of High School Equivalents." *Journal of Labor Economics* 11(1):1-47.

Holzer, Harry J. 1990. "The Determinants of Employee Productivity and Earnings." *Industrial Relations* 29(3):403-22.

Juhn, Chinhui, Kevin M. Murphy, and Brooks Pierce. 1993. "Wage Inequality and the Rise in Returns to Skill." *Journal of Political Economy* 101(3):410-42.

Katz, Lawrence F., and Kevin M. Murphy. 1992. "Changes in Relative Wages, 1963-1987: Supply and Demand Factors." *Quarterly Journal of Economics* CVII(1):35-78.

Krueger, Alan B. 1993. "How Computers Have Changed the Wage Structure: Evidence from Microdata, 1984-1989." *Quarterly Journal of Economics* CVIII(1):33-61.

Levy, Frank, and Richard J. Murnane. 1992. "U.S. Earnings Levels and Earnings Inequality: A Review of Recent Trends and Proposed Explanations." *Journal of Economic Literature* 30(3):1333-81.

Lynch, Lisa. 1988. "Private Sector Training and Its Impact." Mimeograph, MIT.

Mincer, Jacob. 1991. "Job Training: Costs, Returns, and Wage Profiles." In D. Stern and J. M. Ritzen, Eds., *Market Failure in Training?* Berlin: Springer-Verlag, pp. 15-39.

Murphy, Kevin M., and Finis Welch. 1992. "The Structure of Wages." *Quarterly Journal of Economics* CVII(1):285-326.

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