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TRAINING AND THE GROWTH IN WAGE INEQUALITY

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TRAINING AND THE GROWTH IN WAGE INEQUALITY*

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Forthcoming in Industrial Relations

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TRAINING AND THE GROWTH IN WAGE INEQUALITY*

Abstract

Shifts in the incidence of training over the 1980s favored more-educated, more-experienced workers. These shifts coupled with the increase in the returns to skill, suggest that training may have contributed to the growth of between-group wage inequality in this period. Wage equations estimated using data from the 1983 and 1991 CPS files, which include supplemental questions on training, show that training did not contribute much to the growth in between-group wage inequality. It appears that i) the shifts in training were too small and ii) the returns to training did not rise, implying only small fractions of the increases in returns to schooling and experience over this time period can be explained by changes in the distribution of returns to training.

I. Introduction

Wage inequality in the 1970s and 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 at least the early 1980s, although more strongly so in the 1970s (Katz and Murphy, 1992; 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 returns to schooling and experience 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). In this paper we ask whether changes in the distribution of training, or changes in the returns to training, can help to explain or account for the increased returns to schooling or experience.

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 technical change (Bound and Johnson, 1992; Berman, et al., 1993). One implication of this hypothesis should be that the returns to training have increased over this period, as training is one means by which workers acquire the skills that are now in greater demand.[3] Because more-educated and more-experienced workers generally have more training, increased returns to training would have contributed to widening wage differentials associated with schooling and experience.

Supply-based explanations of increases in between-group wage inequality 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, either because of changing selectivity of colleges or changing school quality. However, the evidence is somewhat contradictory. Blackburn and Neumark (1993) find no evidence of a widening ability differential over this period between workers at different schooling levels, while Bishop (1991a) reports that the quality of college graduates relative to high school graduates increased over the 1980s.[4]

Explanations based on quality changes or shifts in the ability-schooling relationship have been criticized because they can at best provide a partial explanation of 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).[5] 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 a worker's career (although theory suggests that it is more likely to occur at young ages). One goal of this paper is to explore further whether quality changes can explain changes in the wage structure over the 1980s. But rather than focusing on school quality or the relative ability of workers with different schooling levels, we examine the role of changes in training. Thus, a potentially important supply-based explanation of the rise in between-group wage inequality--in particular the rise in the return to schooling--is that the distribution of training has changed, possibly favoring more-educated or more-experienced workers.[6]

In our view, asking whether changes in either the returns to training or the distribution of training contributed to the growth of wage inequality in the 1980s is of interest for three reasons. First, demand-driven increases in the returns to skill should be reflected in increases in the returns to training, so we get an additional test of the demand-shift hypothesis, or at least additional knowledge regarding the types or sources of skills for which returns have increased. Second, changes in the distribution of 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.[7] Finally, estimates of the contribution of changes in returns to training or changes in the distribution of training to rising wage inequality are useful in assessing the likely benefits of expanding training for lower-wage workers. This is particularly important in light of efforts to

reverse the recent increase in wage inequality.[8]

II. 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. (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.[9,10] A response indicating that an individual received training in school (especially training to qualify for the current job) is somewhat ambiguous, since they 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 (except those unemployed persons who have never worked), we are ultimately interested in looking at the relationship between training and wages, and hence use data only on employed individuals in the outgoing rotation group, the members of which have wage data. We use the hourly wage when it is reported, and otherwise the weekly wage 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 from 1983 to 1991 dollars using the PCE implicit price deflator, for a top-code of $1390.

The descriptive statistics we report are based on weighted data (as are the regressions). 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 on men, reflecting the emphasis in the literature on changes in their wage structure.

III. Results

Changes in the Distribution of Training

The first question is whether the distribution of training has changed in ways that may have contributed to 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, and the number of types of training, by schooling level, ii) changes in training by level of potential experience, and iii) changes in training by schooling level, within experience groups. Detailed tables on which the following discussion is based are available from the authors upon request, or in Constantine and Neumark (1994).

We first discuss the incidence of training to qualify for the current job. Overall, the proportion reporting any training to qualify for the current job was slightly greater than one-half (.55) in 1983, and rose only slightly (by .015) as of 1991. There were larger (and significant) increases in the proportion reporting in-school training (an increase of .047, or 18.8 percent) and formal company programs (.020, or 16.7 percent), and a significant decrease in the proportion reporting informal on the job training (-.026, or -8.7 percent). The primary question, however, 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 reporting any training fell by .011 (3.8 percent) for high school dropouts and .024 (2.8 percent) for college graduates. The same proportion rose by .023 (4.7 percent) for workers with 0-10 years of potential experience, and rose by .024 (4.4 percent) for workers with more than 20 years of potential experience.

We next turn to a similar analysis for training to improve skills on the current job. For this type of

training, the evidence in favor of relative increases for more-educated and more-experienced workers is quite pronounced. The proportion reporting any training fell by .01 (5.6 percent) for high school dropouts, rose by .024 (7.3 percent) for high school graduates, and rose by .085 (15.5 percent) for college graduates (the latter two changes are significant). A similar, pronounced pattern of larger increases for more-educated workers appears for all types of training with the exception of in-school training, and also appears in the form of increases in the proportions reporting two or more types of training.

Relative increases in training also are apparent for more-experienced as compared with less-experienced workers. For example, the proportion reporting any training rose significantly by .075 (20.8 percent) for the most-experienced group (20 or more years), compared with insignificant increases of .013 (3.9 percent) and .026 (5.9 percent) for the two less-experienced groups (less than 10 years and 10-20 years). A similar pattern of relative increases in training favoring the most-experienced group (and sometimes also the group with 10-20 years of experience) is reflected for each type of training, and in the proportions reporting two or more types of training. Thus, the evidence with respect to training to improve skills on the current job is more suggestive of a role for changes in the distribution of 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 for more-educated workers, for both less- and more-experienced workers. To examine this question, we looked at changes in the proportion reporting training, disaggregated by schooling level, within experience groups. We focus on results for training to improve skills on the current job, the type of training for which changes by schooling and potential experience were most consistent with the observed changes in the wage structure.

Relative increases in training for more-educated workers are apparent for all experience groups, and if anything are sharper for workers with 10-20 or 20+ years of experience. For example, the proportion reporting any such training rose (significantly) by .116 (19.9 percent) for college graduates with 10-20 years of potential experience, and by .109 (20.6 percent) for those with 20 or more years of experience, compared with essentially no

change for inexperienced workers. The incidence of company training increased for college-educated workers in all experience groups. Therefore it appears that changes in training to improve skills on the current job, in particular, could have played a role in widening schooling-wage differentials for more- as well as less-experienced workers.[11,12]

Changes in Between-Group Wage Inequality: Methods

To this point, the evidence on changes in the distribution of training is potentially consistent with changes in training having contributed to the growth of wage inequality in the 1980s. Training to improve skills on the current job increased relatively more for more-educated and more-experienced workers, and increased for more-educated workers among more-experienced as well as less-experienced workers. 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 on this question.

We proceed in three steps. First, we estimate a standard log wage regression that captures the increase in between-group wage inequality in the 1980s, by adding interactions of a year dummy variable with both years of schooling and years of experience, as in

$$(1) \quad \ln(w_i) = \alpha + \beta \cdot S_i + \beta' \cdot S_i \cdot D91_i + \gamma \cdot E_i + \gamma' \cdot E_i \cdot D91_i + \delta \cdot D91_i + Z_i\pi + \epsilon_i \ ,$$

where ln(w) is the log hourly wage, S is years of schooling, 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 2.[13,14] Observations, which may be from 1983 or 1991, are indexed by 'i'. β' and γ' measure the changes in the returns to schooling and experience, respectively, the estimates of which, based on the existing research, we expect to be positive.

If training affects wages, and has increased relatively more for more-educated or more-experienced workers, then there is an omitted variable in equation (1) that is positively correlated with $S_i \cdot D91_i$ and with $E_i \cdot D91_i$ (in addition to being correlated with some of the other variables). This omission is likely to lead to overstatement of the increase in the return to schooling and experience over the sample period, or to upward bias in the estimates of β' and γ'. Thus, our second step is to add to the wage equation dummy variable controls for training (T), as in

$$(2) \quad \ln(w_i) = \alpha + \beta \cdot S_i + \beta' \cdot S_i \cdot D91_i + \gamma \cdot E_i + \gamma' \cdot E_i \cdot D91_i + \delta \cdot D91_i + T_i\lambda + Z_i\pi + \epsilon_i \ .$$

Because this specification controls for changes in the distribution of training, the estimates of β' and γ' from equation (2) measure the increases in returns to schooling and experience not attributable to changes in the distribution of training. Alternatively, by comparing estimates of β' and γ' from equations (1) and (2), we can estimate the extent to which changes in the wage structure over this period are attributable to changes in the

distribution of training.

Finally, we consider the possibility that the returns to training have increased. If they have, then because training is more prevalent among more-educated and more-experienced workers, estimates of equation (2) may still overstate the increases in the returns to schooling or experience.[15] We therefore augment the specification to include an interaction between the training variables and D91, as in

$$(3) \quad \ln(w_i) = \alpha + \beta \cdot S_i + \beta' \cdot S_i \cdot D91_i + \gamma \cdot E_i + \gamma' \cdot E_i \cdot D91_i + \delta \cdot D91_i + T_i\lambda + T_i \cdot D91_i \cdot \lambda' + Z_i\pi + \epsilon_i \ ,$$

which enables us to estimate the increases in the returns to schooling and experience independent of changes in the distribution of or returns to training.

A natural question raised by these specifications is whether any positive association between wages and training represents a causal effect of training, rather than heterogeneity or self-selection bias arising because higher-wage individuals receive more training. The literature on the returns to training establishes--conclusively in our view--that individuals (higher- as well as lower-skilled) experience faster wage growth during periods of training than at other times (Brown, 1989; Bishop, 1991b; Lynch, 1992; Holzer, 1990; Mincer, 1989). However, these studies simply establish that there is a positive causal effect of training on individual wage growth, or that the positive cross-sectional relationship between training and wages is not spurious. In this paper, though, we use cross-sectional estimates of equations (2) and (3) to ask how changes in the distribution of or returns to training have affected the wage structure. Thus, we should potentially be concerned with the magnitude of any self-selection biases in such cross-sectional estimates; knowing that a positive relationship persists in panel data, for example, is not enough to estimate effects on the wage structure. Furthermore, even if biases in the estimated cross-sectional relationship are constant across the years, our answer may be affected, because, for example, an increase in training of highly-educated workers will--if the cross-section estimate of the effect of training on the wage is biased upward--overstate the role of training in explaining the increase in the return to schooling.

The most direct attack on this problem would be to model the self-selection into training. This would require a model of the training decision, and exogenous variables that help to determine training but that do not directly affect the wage. Conceivably, in a rich longitudinal data set one might be able to come up with some variables that plausibly satisfy this criterion. However, in our view the CPS does not offer such variables. We have measures of things such as schooling, tenure, age, industry, and occupation, but all of these are standard ingredients of wage equations. Thus, we do not think that the direct modelling of self-selection into training would

be fruitful with these data. Similarly, because the CPS data are not longitudinal, we cannot eliminate a fixed unobservable associated with training by differencing.

On the other hand, a subset of studies that explore the role of training in panel data also provides cross-sectional estimates with which longitudinal (or selection-corrected) estimates can be compared. Results from three such studies--the only studies we could find that look at relatively general populations, and provide both cross-sectional and longitudinal (or selection-corrected) estimates--are shown in Table 1. The Blanchflower and Lynch (1994) paper suggests that the cross-sectional estimates are downward biased, in contrast to the upward bias we would expect if higher-wage workers self-select into training. However, the other results in the table indicate the upward bias that the usual self-selection story would suggest--although in most cases the biases do not appear to be large--or indicate no bias. Thus, cross-section estimates of the effects of training are probably at worst slightly upward biased.

However, such biases do not drive our conclusions, and if anything appear to strengthen them. If the cross-section estimates--such as those we obtain from the CPS data--are upward biased, then as long as these biases are relatively constant over time, the effect should be that we overstate the contribution of shifts in the distribution of training to changes in the wage structure. As reported below, however, our results--despite any such biases--indicate that shifts in the distribution of training contributed little to shifts in the wage structure. Thus, if we had unbiased estimates of the effects of training, this conclusion would be even stronger.

Changes in Between-Group Wage Inequality: Results

Table 2 reports the main wage regression results.[16] The first column shows estimates of equation (1), the wage equation that allows shifts in the returns to schooling and experience, but does not introduce training variables. The estimates reflect the continuation into this later period of the by now well-established changes in the wage structure. In particular, the estimated return to schooling rises by .021, indicating a wage that is higher by 2.1 percent for each additional year of schooling in 1991 than it was in 1983. We specify the effect of potential experience by including linear through quartic terms, as suggested by Murphy and Welch (1990). We could report the coefficients of each of these terms, and how they change from 1983 to 1991, but it is relatively difficult to interpret such results in terms of changes in the return to experience. Thus, we instead calculate the estimated log wage differential associated with five, 15, and 25 years of experience (relative to zero years of experience), and the changes in these differentials between 1983 and 1991. The log wage differential associated with experience

increased at each of these experience levels, by .034 at five years of experience, .067 at 15 years of experience, and .079 at 25 years of experience.

Column (2) reports the estimates of equation (3), where we simply add a dummy variable for any training, and an interaction of this dummy variable with the 1991 dummy variable.[17] In this table, we focus on training to improve skills on the current job, because the changes in the distribution of this training variable appeared most consonant with changes in the wage structure. The estimated coefficient of the training variable is significant, and indicates that training is associated with wages that are higher by nearly 15 percent. On the other hand, there is no significant increase in the return to this training from 1983 to 1991; the estimated coefficient of the interaction variable is an insignificant .008. Most importantly, the changes in the wage structure from 1983 to 1991 are not moderated much by the inclusion of the training variables. The return to schooling is estimated to rise by .019, 9.5 percent less than in column (1). The returns to experience are estimated to rise by .034, .062, and .070 at five, 15, and 25 years of experience. The increase at five years is as large as in column (1), and those at 15 and 25 years are about 10 percent smaller than the increases reported in column (1).

Column (3) reports estimates of a similar specification, which differs by including dummy variables for each type of training (now including "other" training), and interactions of these dummy variables with the 1991 dummy variable. Each type of training is significantly positively associated with wages, with the estimates ranging from .055 (for informal on the job training) to .189 (for formal company training). However, there is no evidence of increases in the returns to training. For in-school training and informal on the job training, the estimates indicate that, if anything, the returns to training fell, although the estimates are not statistically significant. The estimated changes in returns to training are positive, but smaller and even less significant, for formal company and other training. The inclusion of the more disaggregated training variables does no more to explain changes in the wage structure. The return to schooling is now estimated to increase by slightly more (.020) than in column (2), and the estimated increases in the returns to experience are within about 10 percent of those in column (1).

Thus, to this point, the estimates indicate that changes in the distribution of and returns to training contributed relatively little to changes in the wage structure from 1983 to 1991. The first row of Table 3 summarizes the results, reporting the percentage of the increase in the return explained in column (3) of Table 2, relative to column (1).[18] For example, adding the training variables and their interactions in column (3) to the specification in column (1) explains only 5.8 percent of the increase in the return to schooling.

Table 3 then goes on to report similar calculations for alternative samples and wage equation specifications. The next three rows report results when the specifications in columns (1) and (3) of Table 2 are estimated for separate experience groups, to assess the role of training in explaining the increase in the return to schooling for different experience groups. For the least-experienced group, the training variables account for virtually none of the increase in the return to schooling (0.5 percent). For the group with 10-20 years of experience, the increase in the return to schooling is actually greater once the training variables are included. For the most-experienced group, the training variables explain a higher percentage of the increase in the return to schooling (13.1 percent). This is interesting, because it was the possibility that training, rather than changes in school quality or ability, explained the increase in return to schooling among more-experienced workers, that was part of the motivation for looking at the role of training in generating changes in the returns to schooling and experience. Nonetheless, in our view we explain relatively little of the increase in the return to schooling, even for this group.

The next row of Table 3 reports the results of allowing different effects for each type of training, but not allowing the returns to training to change over time, by estimating equation (2) rather than equation (3). The percentages of the increases in the returns to schooling and experience that are explained in this specification are similar to those in the first row; if anything they are slightly higher, reflecting the results in column (3) of Table 2 that some of the estimated changes in the returns to training are negative. In the next two rows we first include dummy variables for each type of training to qualify for the current job, and then also include interactions of these variables with the 1991 dummy variable. In the latter specification, the percentage of the increase in the return to schooling that is explained rises slightly, to 11.3 percent. But the increases in the return to experience at each level of experience reported in the table are actually larger, as indicated by the negative values for the percentage explained in the table. The next to last row excludes the in-school training variables, since in-school training may simply reflect schooling, and the last row includes tenure variables. The results for these specifications are similar to the others in the table.

Overall, the results in Tables 2 and 3 support two conclusions regarding the role of training in generating the rise in between-group wage inequality. First, in contrast to what we might expect based on other evidence that the returns to skill increased, the returns to training did not increase over this period. Second, changes in the distribution of training account for at most relatively small percentages of the increases in the returns to schooling and experience over this period. Depending on the specification and sample, changes in the distribution of and

returns to training explain 2.3 to 13.1 percent of the increase in the return to schooling. Changes in the distribution of and returns to training explain about six to 12 percent of the increase in the return to experience, although one specification suggests that the return to experience would have risen by more, not less, absent changes in the distribution of and returns to training.

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 the increase in the return to schooling (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 4 provides some evidence documenting the linkages between training, computer training, and computer use. The first row of panel A reports the proportion of those reporting each type of training to improve skills on the current job who also report that the training taught computer skills. The numbers reveal that, depending on the type of training, between 30 and 39 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, about one-half of those who received training use a computer every day. In addition, workers who did not receive training are much less likely to use computers at work, as the last column reveals. Panel B shows the proportion reporting computer-related training, classified by computer use at work, and indicates that computer use at work is related to computer training. Virtually no workers (one percent) of those reporting computer-related training report that they never use a computer at work, whereas 28 percent of those who use a computer every day report computer-related training.

The figures in Table 4 relating training to computer use at work might 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. In fact, though, 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 of return to education observed between 1984 and 1989" (1993, p. 55).

However, while Table 4 documents positive relationships between training, computer-related training specifically, 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.[19] Therefore, some of the increased use of computers at work may be independent of training, at least insofar as we measure such training. In addition, Table 4 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.

Panel C of Table 4 presents some evidence on these questions. We first add to the basic specification in column (1) of Table 2 dummy variables for computer use at work, and report the estimated coefficients of these dummy variables in the first row.[20] These estimates are large and significant, in line with the magnitudes reported by Krueger (although his estimates are for men and women). In particular, computer use every day is associated with the largest wage differential. Next, we add dummy variables for each type of training, as in column (3) of Table 2. The estimated coefficients for computer use fall by about one-quarter, but they remain large and statistically significant. This suggests that computer use is associated with higher wages, independently of the training a worker has received. We also estimated this specification including a dummy variable indicating whether the training was computer-related. The estimated coefficients of the computer-use dummy variables were nearly identical, and the estimated coefficient of this training variable was actually negative.[21] Thus, computer use is associated with higher wages even independently of computer-related training, and the return to computer-related training is no higher than the return to other training. On the one hand, these results help to explain why we find that changes in the distribution of and returns to training contributed little to changes in the wage structure, while changes in computer use apparently contributed relatively more. On the other hand, 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 associated with computer use.

IV. Conclusion

Shifts in the incidence of various types of training over the 1980s favored more-educated, more-experienced workers. In addition, other evidence on increased returns to skill suggests that the returns to training should have increased. Given that training is associated with higher wages, and that training is more prevalent among more-educated and more-experienced workers, changes in the distribution of and returns to training may have contributed to the growth of wage inequality in this period. However, wage regression results indicate that only small proportions of the increases in the returns to schooling and experience are explained by changes in the distribution of training across schooling and experience groups, and changes in the returns to training. This is because the returns to training did not in fact increase, and because the changes in the distribution of training were not sufficiently large to have substantial effects on the wage structure, given the size of the effect of training on wages.

None of this is intended to say that training cannot be used to boost the wages of lower-wage workers. In addition, there may be long-term reasons for the lower incidence of training among less-educated, lower-wage workers, which may be amenable to policy intervention. However, in policy debates regarding approaches to increasing the relative pay of less-educated and younger workers, it is important to understand that the relative wage declines that such workers experienced in the past 10-15 years are for the most part not attributable to absolute or relative declines in 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. For example, Krueger (1993) shows that the return to use of computers at work has increased.

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

5. 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.

6. There are at least two existing empirical clues that suggest this is a promising hypothesis. 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 computer use at work rose relatively more for more-educated workers. It seems plausible 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).

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

8. For a pessimistic assessment of the possibility of accomplishing this via increased training, see Heckman (1993).

9. 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.

10. 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, 1991b).

11. Changes in the distribution of training can explain widening schooling-wage differentials for more-experienced as well as less-experienced workers only if some of the increased training of more-experienced, more-educated workers occurred at the same time that schooling differentials were widening, rather than in the distant past. (That is, increased training must be partly a period effect, and not just a cohort effect.) Otherwise, changes in the distribution of training could not have contributed to the widening of the schooling-wage differential for less-experienced workers. This is an implicit assumption, although it cannot be definitively established in the CPS data. However, the median job tenure of male workers was 6.8 years for those aged 35-44, and 11.6 years for those aged 45-54 (Farber, 1994). It therefore seems plausible that at least some of the training to improve skills on the current job, for more-experienced workers, is relatively recent.

12. In Constantine and Neumark (1994) we also examine data on length of training programs, since the duration of training, and not only its incidence, is likely to affect wages (Mincer, 1989; Barron, Berger and Black, 1993). Because of the ambiguity regarding the interpretation of in-school training, we focused only on the length of formal company training programs. With respect to training to qualify for the current job, there were relative increases in the length of training for more-educated and more-experienced workers. The results for training to improve skills on the current job were more ambiguous. Disaggregated by experience group, the results paralleled those for training to qualify for the current job, although the changes were less sharp. However, the results were reversed by schooling level, where the least-educated had the sharpest increases in length of programs.

13. We include higher-order experience terms, but for expository purposes here refer only to the linear term.

14. We originally intended to consider within-group inequality as well. However, it turns out that in these data evidence on changes in within-group wage inequality between 1983 and 1991 is ambiguous. 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 2, the 50th-10th difference rose from .56 to .57 from 1983 to 1991, while the 90th-50th difference fell from .51 to .50. The absence of an unambiguous rise in within-group inequality from 1983 to 1991 is not inconsistent with earlier evidence documenting the rise in this dimension of inequality, evidence which focused on earlier years and did not extend out to 1991. For example, the CPS data used by Katz and Murphy (1992) only extend through 1987, and in their data residual wage inequality for men levels off by 1983 or 1984, after rising sharply through the 1970s (Figure II, p. 45). The CPS data used in Juhn, et al. (1993) extend through 1989. Their data reflect a similar levelling off of within-group wage inequality by 1984, but additional increases in 1988 and 1989 (Figure 7, p. 427).

15. That is, there is an omitted variable $\lambda' \cdot T_i \cdot D91_i$ that, because training is positively correlated with schooling and experience, is positively correlated with $S_i \cdot D91_i$ and $E_i \cdot D91_i$, and hence (assuming $\lambda' > 0$) leads to upward bias in the estimates of β' and γ'.

16. Throughout the wage equation analysis, we ignore issues of selection into employment. This is unlikely to be much of an issue since we study men. In addition, modeling such selection requires data for all individuals on the determinants of market wages, such as training, that appear in the wage equation. But the training questions in the CPS are not asked of those out of the labor force.

17. Below, we report abbreviated results for equation (2).

18. The percentages do not correspond exactly to what one could compute from Table 2, because Table 2 reports estimates rounded to two or three places to the right of the decimal point.

19. For example, 72 percent of those using computers every day did not report computer-related training.

20. The only difference is that the year interactions are omitted, since the computer-use and computer-training data are available only in 1991.

21. We also estimated the specifications with interactions between the computer use and computer training variables, to check whether the returns to computer-related training are higher for those who use computers at work (or, alternatively, whether the returns to computer use at work are higher for those who receive computer-related training). In fact, 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 estimated coefficients of the computer use dummy variables were unchanged, so the results continue to suggest that there are significant wage differentials associated with computer use at work, independently of training.

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Table 1: Evidence on Self-Selection Bias in Cross-Section Estimates of the Effects of Training on Wages[a]

Author	Data	Cross-section estimates		Fixed-effects estimates	Selectivity-corrected estimates
Lynch (1992)	NLSY	Previous weeks of on-the-job training:	.0002 (.17)	-.0002 (.17)	-.0001 (.06)
		Previous apprenticeship, weeks:	.004 (3.29)	.002 (2.05)	.003 (3.33)
		Previous weeks of off-the-job training:	.002 (5.23)	.002 (4.38)	.002 (3.07)
Blanchflower and Lynch (1994)	NLSY, non-college grads	Previous company training (dummy):	-.03 (.65)	.12 (1.94)	
		Previous off-the-job training (dummy):	.03 (2.07)	.05 (1.02)	
		Ever had apprenticeship (dummy):	.19 (3.16)	.38 (3.38)	
Bartel (1992)	Company data set, professional employees	Days of formal training:	.002 (4.49)	.001 (4.46)	

a. Estimates are for log wage or log earnings equations. T-statistics are reported in parentheses. These results are for samples including men and women. Blanchflower and Lynch report similar results for men only, and Lynch reports similar cross-section and fixed-effects estimates for white men only.

Table 2: Log Wage Equation Estimates Incorporating Training, 1983 and 1991 CPS Samples, Men[a]

	(1)	(2)	(3)
Years of schooling	.068	.062	.061
	(.002)	(.002)	(.002)
× 1991	.021	.019	.020
	(.003)	(.003)	(.003)
Potential experience, log wage differential[b]			
5 years	.30	.29	.29
15 years	.62	.60	.59
25 years	.70	.69	.68
5 years × 1991	.034	.034	.031
15 years × 1991	.067	.062	.060
25 years × 1991	.079	.070	.070
<u>Training to improve skills on current job</u>			
Any training	...	.149	...
		(.013)	
× 1991	...	.008	...
		(.017)	
In-school	...	...	.103
			(.019)
× 1991	...	...	-.033
			(.025)
Informal on the job	...	...	.055
			(.017)
× 1991	...	...	-.030
			(.022)
Formal company	...	...	.189
			(.018)
× 1991	...	...	.002
			(.022)
Other	...	...	.102
			(.031)
× 1991	...	...	.017
			(.038)
$\bar{R}^2$	.435	.448	.452

a. Other control variables included are: dummy variables for 1991, married with spouse present, residence in the south and in urban areas, and black. For training to qualify for the current job, there is a residual "other" training category, which is a combination of responses including training from correspondence courses, informal training from a friend, or other training. For training to improve skills on the current job, there is a residual "other" training category, which is a single response distinct from the other training categories indicated in the table. Estimates are based on 6994 observations in 1983, and 5825 observations in 1991. Estimates are based on weighted data.

b. Linear, quadratic, cubic, and quartic terms, and their interactions with a dummy variable for 1991, are included.

Table 3: Additional Analyses of Log Wage Equation Estimates Incorporating Training, 1983 and 1991 CPS Samples, Men[a]

	Percentage of Increase in Return Explained			
Specification	Years of Schooling (1)	Experience (at 5 years) (2)	Experience (at 15 years) (3)	Experience (at 25 years) (4)
Table 2, column (3)	5.8	8.0	10.1	10.8
Potential experience < 10[b]	0.5	...	...	...
10 ≤ Potential experience < 20	-2.9	...	...	...
Potential experience ≥ 20	13.1	...	...	...
Exclude training × 1991 interactions	9.9	9.3	12.7	13.7
Include dummy variables for training to qualify for current job	12.6	14.3	12.3	8.1
Include dummy variables for training to qualify for current job, and interactions with 1991	11.3	-7.2	-10.3	-12.6
Exclude in-school training variables	9.6	8.0	12.2	13.7
Include linear-quartic tenure variables[c]	2.3	3.5	5.7	6.8

a. Each specification is a variation of the specification in column (3) of Table 2. See footnotes to Table 2 for additional details.

b. Linear through quartic potential experience terms are included in the regression for each subgroup.

c. The tenure variables are also included in the "baseline" specification (equation (1)) from which the increases in returns to schooling and experience are estimated.

Table 4: 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[a]

	In-school	Informal on the job	Company training	No Training
A. Proportion reporting training in computer-related skills	.39	.30	.36	.00
Proportion reporting use of a PC or computer terminal:				
Never	.27	.38	.26	.69
Less than once per week	.07	.06	.08	.04
One or more times per week	.12	.09	.09	.05
Every day	.54	.47	.57	.23
	Never uses computer	Uses computer less than once per week	Uses computer one or more times per week	Uses computer every day
B. Proportion reporting training in computer-related skills	.01	.10	.16	.28
C. Regression estimates of effects of computer use on log wages:[b]				
Excluding training variables	...	.19	.18	.26
		(.03)	(.02)	(.01)
Including training variables	...	.14	.13	.20
		(.03)	(.02)	(.01)

a. Estimates are based on 5756 observations in 1991. The sample is slightly smaller than in the preceding tables because of non-response to the computer use questions. Estimates are based on weighted data. See footnotes to Table 2 for more details.
b. Based on the same specification as in column (1) of Table 2 (although with 1991 data only), with the addition of dummy variables for computer use. In the second row, we add the training dummy variables included in column (3) of Table 2.

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