Worker training: what we've learned from the NLSY79

The 1979 cohort of the National Longitudinal Survey of Youth has been a wellspring of knowledge about worker training and a valuable means of empirically testing human-capital theory

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How individuals obtain their skills and how they are paid for the use of those skills are concepts that are fundamental to the field of labor economics. Productive skills are often referred to as "human capital." The basic idea of human-capital theory is that workers invest in their own skills in order to earn higher wages, much as persons invest in financial or physical assets to earn income. Although this idea goes back at least to Adam Smith, modern human-capital research was originated in the late 1950s by economists Theodore Schultz, Jacob Mincer, and Gary Becker. Their ideas, focusing on investments in and returns to education and training, have provided the theoretical and empirical basis for decades of ensuing research.[1]

Much of the empirical research on the topic of human capital has analyzed the relationship between education and wages. This focus on education is due to the abundance of high-quality data sources with information on both education and wages. For example, analysts using cross-sectional data from the Current Population Survey (CPS) have found that individuals in the United States receive earnings that are approximately 10 percent higher for every additional year of schooling they have completed.[2] Kenneth I. Wolpin's article on education in this special edition of the *Monthly Labor Review* shows that, over the 15-year period between ages 25 and 39, a male college graduate earns 80 percent more than a male high school graduate without any college, and a male high school graduate earns 57 percent more than a high school dropout.

However, empirical research on training—the other key component of human capital—has lagged research on the economics of education. The human-capital model yields straightforward predictions about the relationship of on-the-job training to wages, wage growth, and job mobility; still, as will become clear, testing these predictions requires good longitudinal microdata.

The need for high-quality longitudinal microdata with detailed information about wages, mobility, and on-the-job training has led researchers to the National Longitudinal Surveys for empirical analyses of training. This article both provides a brief summary of the human-capital model as it relates to on-the-job training and summarizes the empirical training literature, with a special focus on the contributions that analyses of the data from the 1979 cohort of the

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National Longitudinal Survey of Youth (NLSY79) have made to that literature.

The human-capital model

Models of competitive labor markets imply that wages paid to workers reflect their productivity. For example, if education makes workers more productive, then higher wages are paid to more highly educated persons. Similarly, if on-the-job training makes workers more productive, then trained workers should receive higher wages than workers with no training. But education and on-the-job training differ in one key aspect: most workers finish their schooling before entering the labor market, whereas most on-the-job training occurs during a worker's tenure with an employer. While education and on-the-job training are both productivity-enhancing investments, they potentially differ with regard to whether the worker or the employer pays the costs.

Any investment in human capital involves current costs and future benefits. The costs associated with on-the-job training involve both direct costs, such as the salaries of the persons doing the training and any costs of materials, and indirect costs, such as the cost of taking trainees away from their current productive tasks. The benefits of on-the-job training accrue to both the firm providing the training and the worker receiving the training: because the worker is more productive after the training, the firm benefits from higher productivity and greater output, and the worker benefits from his or her higher productivity in the form of higher wages. One key theoretical issue regarding on-the-job training concerns the division of these costs and returns between the firm and the worker.

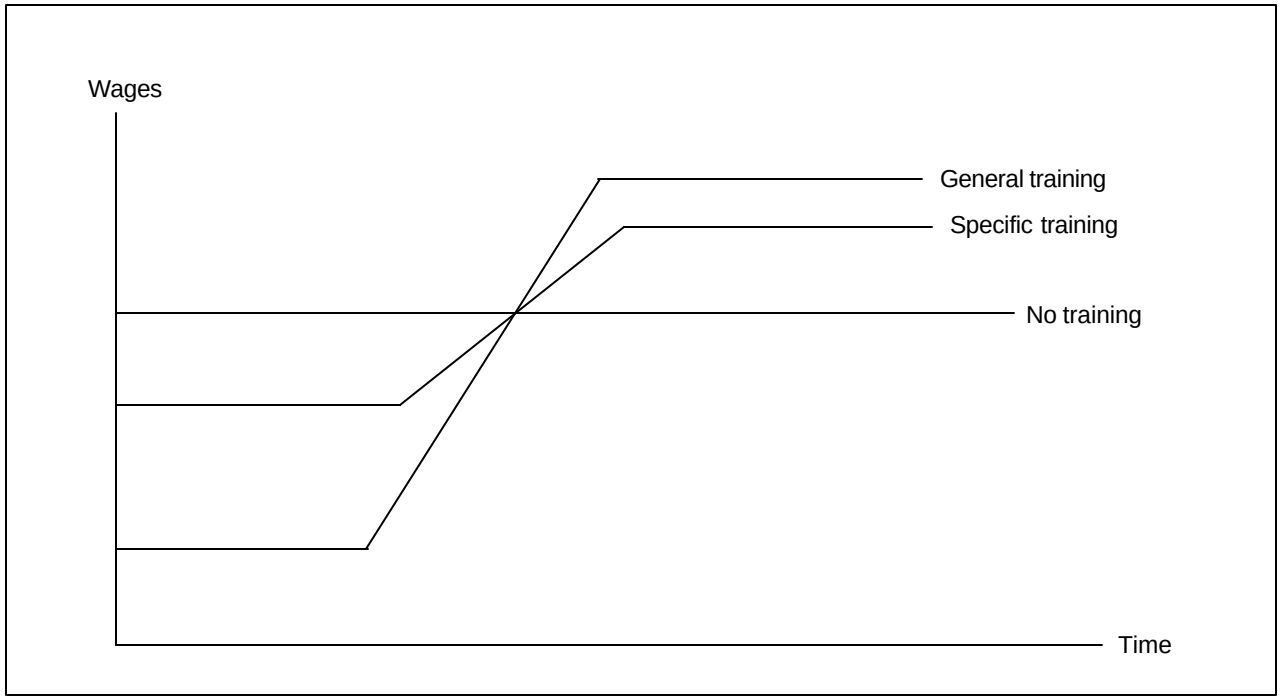
Gary Becker made progress on this cost-sharing issue by defining two types of training: *general training* and *specific training*. Completely general on-the-job training is training that provides the worker with skills that are productive at firms other than his or her current employer. Examples of completely general training are learning to use a word-processing or data-processing computer program that is available for purchase by any firm, pilots learning to fly a type of jet airplane that is in the fleet of several airlines, and doctors learning a new surgical technique that could be conducted at any hospital. By contrast, completely specific on-the-job training is training that enhances the productivity of the worker at only the firm providing the training. Examples of completely specific training are astronaut training (presumably specific to the National Aeronautics and Space Administration), learning to drive a tank (presumably specific to the U.S. Military), and learning to operate a machine that was developed and is used by only one manufacturing firm to produce its product. In the real world, almost all training involves a combination of both general and specific skills.

In a competitive labor market, workers are paid for the skills they possess. Becker reasoned that, because general training provides skills which are useful at all firms, the firm offering the general training will need to pay the trained worker a wage that reflects these skills; otherwise the worker will leave the firm to receive a higher wage at a different firm. Anticipating this possibility, a profit-maximizing firm will not pay any of the costs of general training because it cannot extract any of the returns from the training. In that case, the worker will pay all the costs of the general training—not just the direct costs, but also the indirect costs that reflect the worker's lost productivity to the firm. Human-capital theory thus predicts that, relative to workers who do not receive training, workers who receive general training will be paid lower wages while receiving the training and higher wages after the training is complete. This hypothesis is depicted in exhibit 1, which compares the wage profile of a worker who receives no training with that of a worker who receives general training.

Sharing the costs and returns of specific training is more complicated. On the one hand, assume, for the moment, that, as with general training, a worker pays all the costs and receives all the benefits of specific training. In such a case, a worker who might be fired or laid off after receiving the training would receive no future returns from his or her investment in specific training; thus, the worker would have less incentive to pay for the training, because the decision to lay the worker off is made by the firm. On the other hand, assume that a firm pays all the costs and receives all the benefits of specific training. In this case, the firm would receive no future returns from the investment if the trained worker quit for another job; thus, the firm would have less incentive to pay for the training, because the decision to quit is made by the worker. The solution to this dilemma is for the worker and the firm to share the costs and returns of specific training, with the exact division of the returns depending upon the wage elasticity of the worker's propensity to quit and the firm's propensity to lay the worker off.[3] This sharing is portrayed in exhibit 1: the wage profile of a worker who receives specific training shows the worker paying some (but not all) of the costs and receiving some (but not all) of the returns.

The sharing of the costs and returns to training has implications for worker mobility. Workers who have received specific training have higher productivity at their current employer than at other employers, and their wage at the current employer is higher than the wage they could obtain from other employers. This asymmetry results in workers with specific training having lower probabilities of quitting than workers with no specific training. Similarly, because the productivity of workers with specific training exceeds their wage, the employer is less likely to lay off workers with

Exhibit 1. Wage profiles



specific training relative to workers with no specific training. By contrast, because workers with general training have the same productivity at the current employer as at other employers, and because the wage they receive from their current employer equals the wage they would expect from other employers, the provision of general training does not lower expected probabilities of quitting. Similarly, in the simple model presented here, firms could replace a worker with completely general training without loss of any productivity, so the provision of general training does not lower expected probabilities of layoffs.

In sum, this simple, yet elegant, human-capital model has several testable predictions. First, training lowers the starting wage: during training, a worker accepts a lower wage relative to a worker not receiving training, all other things being equal. Second, training raises future wages at the employer providing the training: a worker who has received on-the-job training should receive higher wages relative to a worker with no training—again, all other things being equal. Third, by definition from the preceding two predictions, training raises wage growth at the employer providing the training. Fourth, the foregoing three predictions vary in magnitude as a function of whether the training is specific or general. Finally, specific training lowers worker mobility, whereas general training has no effect on worker mobility, all other things being equal.

These testable predictions provide the framework for empirical analysis. It is obvious that several demands are being placed on the data. First and foremost, there needs to be information on training and individuals' wages. Furthermore, longitudinal microdata are necessary for analyzing wage growth and mobility. Finally, the information needs to be quite detailed in order to distinguish general training from specific training. The NLSY79 data satisfy all these criteria and make up one of the few data sets that provide detailed longitudinal information on all the necessary analytical variables. It is not surprising, then, that much of what we know about on-the-job training has come from analyses of the NLSY79 data.

Before we turn to the empirical findings, the importance of the phrase "all other things being equal" needs to be mentioned. A common finding from all data sets with training information is that individuals who receive training are not a random sample from the population of all workers. For example, those who are college educated and those with higher ability are more likely to receive training.[4] This nonrandom selection affects how we interpret the empirical analysis that follows. (This issue is more fully explained later in the article.)

Table 1. Questions about training, NLSY79, 1988–2000[1]

Question	Mean[2]
19. Since [date of the last interview] did you attend any training program or any on-the-job training designed to help people find a job, improve job skills, or learn a new job?	
Yes: Continue to 20	.158
No: Skip to next section of questionnaire	.842
20. Which category on this card best describes where you received this training? [Code one only]	
Business school..	.030
Apprenticeship program	.021
A vocational or technical institute	.097
A correspondence course	.029
Formal company training run by employer or military training	.375
Seminars or training program at work run by someone other than employer	.158
Seminars or training programs outside of work	.184
Vocational rehabilitation center	.013
Other (Specify: _____)	.078
21. Who paid for this training program? [Code all that apply]	
Self or family	.139
Employer	.739
Job Training Partnership Act	.021
Trade Adjustment Act .	.001
Job Corps Program	.001
Work Incentive Program	.004
Veteran's Administration	.002
Vocation Rehabilitation	.011
Other (Specify _____)	.092
25. Altogether, for how many weeks did you attend this training?	5.7
31. How many hours per week (do/did) you usually spend in this training?	20.1

[1] The training questions in 1988, 1996, 1998, and 2000 had a 2-year reference period. The training questions in 1989–1994 had a 1-year reference period.

[2] All entries are unweighted tabulations from the 1988–2000 NLSY79 microdata. The sample size for question 19 is N = 91,144. All means for questions 20, 21, 25, and 31 are computed from the sample of respondents who said "yes" to question 19. The mean for question 25 is computed from the sample of respondents whose training program had been completed by the date of the interview.

Empirical findings from the early literature

Early on in the development of human-capital theory, economists recognized that on-the-job training was an important source of investment in human capital. Because on-the-job training data were not available, the earliest attempts to measure such training were indirect. As has been noted, models of competitive labor markets imply that workers will be paid in accordance with their productivity. The tendency of wages to increase with labor market experience was interpreted as evidence of training-induced increases in productivity. With additional assumptions, the wage-experience relationship could be used to infer an investment path and returns to the training investment.

Mincer's 1962 article attempted to estimate the amount of training by comparing the earnings path of individuals with different amounts of education and assuming that returns to training were the same as returns to schooling.[5] Mincer's 1974 book was probably more influential; in it, he showed that if time spent in training increased the logarithm of wages linearly, and if the percentage of working time spent in training declined with experience in a linear manner, then wages would be well described by a quadratic function of experience.[6] The quadratic earnings function was found to be a fair approximation of earnings and won wide acceptance.[7]

This evidence was clearly imperfect. Moreover, in the late 1970s, economists developed other theories to explain the tendency of wages to rise with experience, ranging from improvements in job matches through a worker's career to firms tilting their wage profiles to discourage shirking or encourage more stable workers to apply.[8] Evidently, more direct measures of on-the-job training were needed.

One such measure was included in the Panel Study of Income Dynamics (PSID), a longitudinal survey administered annually since the 1960s. In 1976 and 1978, the PSID asked the question, "On a job like yours, how long would it take the average new person to become fully trained and qualified?" Articles by Greg J. Duncan and Saul Hoffman in 1979 and James N. Brown in 1989 used this question to identify periods of on-the-job training and adjust earnings equations accordingly.[9] The longitudinal structure of the PSID allowed Brown to directly examine the effect of training on wage increases, rather than inferring wage increases from cross-person comparisons. Both articles found a substantial effect of training on wages, providing evidence for the human-capital interpretation of wage increases. However, the PSID question clearly affords only a limited measure of on-the-job training. As Duncan and Hoffman noted, the intensity of training during the training period may vary between persons with identical answers to the question, and the type of training—formal, informal, or learning by doing—is completely unspecified.

Aside from the NLSY79, other attempts to measure on-the-job training in surveys of individuals include earlier cohorts of the National Longitudinal Surveys (NLS) and supplements to the CPS in 1983 and 1991. Lee A. Lillard and Hong W. Tan used the 1983 CPS and the early cohorts of the NLS to examine training and its effect on labor market outcomes.[10] The CPS supplement asks what training was needed for the respondent to obtain his or her current or previous job and inquires about training to improve skills on the current job. Because the CPS is not a longitudinal survey and because the period during which the training took place is unclear, only the association of training with differences in wages between persons (which is substantial) can be examined; wage changes due to training for a given individual cannot be tracked. The training questions in the earlier cohorts of the NLS are broadly similar to, but less extensive than, those in the NLSY79 (and the employment data in the earlier cohorts are not as good). Moreover, they cover only the "longest" training event between surveys, so they do not provide a comprehensive record of formal training. Exploiting the longitudinal nature of the NLS to examine the effect of training on wages several years later, Lillard and Tan found evidence that training does depreciate.

Training data in the NLSY79

This section describes several of the key training questions in the NLSY79 survey instrument. Readers interested in more documentation about the NLSY79 training questions may consult the NLS Users' Guide.[11] As mentioned there, the training questions in the survey changed in the mid-1980s. The initial, 1979–86 rounds of the NLSY79 were funded by the Employment and Training Administration (ETA) of the U.S. Department of Labor. The ETA was concerned with the efficacy of various federally funded employment and training programs in helping youths to acquire skills and secure employment. Data collection during the 1979–86 interviews was limited to only those training programs in which the respondent had been enrolled for 1 month or more; analysis of the microdata from 1988 to 2000 indicates that 66 percent of completed training spells are less than 4 weeks in duration. In 1987, when funding of the NLS shifted to the Department of Labor's Bureau of Labor Statistics, the collection of extensive information on government training ceased, and the "Other Training" section of the questionnaire was restructured. The limitation of 1 month's duration was dropped in the 1988 and later questionnaires. The 1987 survey was an abbreviated telephone interview, and only one question was asked about whether any training or assistance had been received from any government-sponsored program.

The key training questions from the 1988–2000 NLSY79 surveys are listed in table 1, along with unweighted means. In each of the surveys between 1988 and 2000, the incidence of training is elicited with the question, "Since [date of the last interview] did you attend any training program or any on-the-job training designed to help people find a job, improve job skills, or learn a new job?" The statistics in table 1 tell us that 15.8 percent of persons have received training since the date of their last interview.[12]

One advantage of a longitudinal survey such as the NLSY79 is that one can examine the incidence of training over several years. Table 2 reports the cumulative incidence of training spells for the sample of individuals who responded to every interview between 1989 and 1994. Surveys for these 6 years were chosen because each has an annual reference period for the training question. Over the course of those 6 years, when individuals in the NLSY79 ranged from 24 to 37 years of age, 53.2 percent of respondents never received any training. Of those persons who did get training at least once during the 6-year period, roughly half (24.1/46.8) received

Table 2. Cumulative incidence of training, sample of 8,095 individuals who responded to each interview, 1989–94

Number of training spells	Count	Percent
0	4,307	53.2
1	1,947	24.1
2	994	12.3
3	516	6.4
4	208	2.6
5	99	1.2
6	24	.3

NOTE: Entries are unweighted tabulations from the 1989–94 NLSY79 microdata.

only one spell of training, and roughly one-quarter (12.3/46.8) received two spells of training.

Individuals who answer "yes" to the question on the incidence of training are then asked where they received their training. The most frequent type of training is formal company training (37.5 percent of all training spells); noncompany seminars or training programs also are a frequent type of training (34.2 percent of all training spells, broken down into 18.4 percent consisting of seminars or training programs outside of work, and 15.8 percent seminars or training programs at work run by someone other than the employer). Vocational or technical institutes are the fourth most-frequent type of training (9.7 percent of all training spells). As mentioned later in the article, researchers have found that this question about the type of training provides important information about the generality of training.

The next question in the training sequence asks who paid for the training program. The most frequent response is "the employer," who pays for 73.9 percent of all training spells. Researchers have made several interesting points regarding this question. First, the question supplies some of the data that are necessary to analyze the interesting theoretical question of who pays for general and specific training. (The empirical literature on the subject is summarized in a later section of the article.) Second, many researchers restrict their analyses to employer-paid training spells; the human-capital model is an on-the-job training model, and deleting nonemployer paid spells of training aligns the theory with the empirical work.

The duration of training is just as important as the incidence. Table 1 indicates that the mean completed training spell lasts 5.7 weeks and 20.1 hours per week. Table 3 gives statistics on the distribution of the duration of completed training spells. The distribution of weeks of training is heavily skewed to the right, with half of all completed training spells less than or equal to 1 week in duration, but 5 percent greater than 24 weeks. Total hours of training follow a similar pattern: half of all completed training spells are less than or equal to 35 total hours, but 5 percent are greater than 520 total hours.

Table 3. Distribution of training durations, NLSY79, 1988–2000

Percentile	Number of weeks	Hours per week	Total hours
Mean	5.7	20.1	118.3
25th	1	6	12
50th	1	16	35
75th	6	40	80
95th	24	40	520
99th	52	65	1,440

NOTE: Entries are unweighted tabulations from the 1988–2000 NLSY79 microdata.

Empirical findings

Wages and wage growth. Lisa Lynch's 1992 article in the *American Economic Review* is the most prominent early study using NLSY79 data to examine the effect of training on wages.[13] Lynch uses data from 1980 through 1983 to estimate the effect of training on 1983 wages for youths who had completed their education by 1980 with less than a college degree. (Note that 1980 is too early to have a substantial sample of college graduates from the 1979 survey.) She classifies training as on the job, off the job, and apprenticeship, and she reports descriptive statistics showing that 4.2 percent of individuals received on-the-job training for an average of 31.2 weeks, 14.7 percent of individuals received off-the-job training for an average of 40.9 weeks, and 1.8 percent of individuals received apprenticeship training for an average of 63.5 weeks. She takes advantage of the longitudinal nature of the NLSY79 to construct measures of cumulative weeks of training in each category.

Lynch estimates both an equation for 1983 wages and an equation for wage growth from 1980 to 1983. The wage growth equation is used to eliminate possible selection bias in the wage-level equation: workers who receive training may have some unobservable characteristic, such as high ability, that is positively correlated with both wages and training. In that case, because more able workers would get trained, comparing wage levels of different workers would bias wage differentials between trained and untrained workers. But examining wage changes for a given worker will correct this source of bias if ability is fixed over time for a given individual. Lynch's wage-level equation implies that off-the-job training and apprenticeship training from previous employers, and on-the-job training and apprenticeship training with the current employer, significantly raise wages. In addition, the wage growth equation implies that off-the-job training and apprenticeship training raise wages, but that on-the-job training has no effect on wages.

In a later study paralleling Lynch's methods, Jonathan Veum uses data from the 1986–90 surveys to measure the impact of training on wages.[14] Unlike Lynch, Veum is able to include in his analysis all training spells, whether they were less than or greater than 1 month in duration. His 1990 wage-level equation yields no statistically significant effect of any form of training when training is measured continuously, but does show some significant effects of company training and off-the-job seminars when training is measured in terms of its *incidence*. His results for wage growth between 1986 and 1990 are similar.

Daniel Parent uses a specification similar to that of Lynch and Veum, with data from the 1979–91 surveys.[15] Although the wage growth equations in the earlier papers eliminate bias due to unchanging personal characteristics, Parent notes that jobs with higher wages may also have more training

irrespective of the individual. Parent gets around this problem by using information on the deviation of the stock of training from within-job means. He finds fairly substantial effects of both off-the-job and on-the-job training. His correction for job bias substantially reduces the effect of apprenticeships, although the effect of previous jobs' apprenticeship training remains statistically significant.

Paul Lengermann used the NLSY79 to examine the question investigated by Lillard and Tan: How does the effect of training on wages evolve over time?[16] Unlike those researchers, Lengermann examines wage *growth* in contrast to wage *levels*, so as to avoid bias due to the differing abilities of workers. He examines both spells of training that lasted 4 weeks or longer (available throughout the sample) and spells of training of less than 4 weeks (for which detailed information is available only after 1986). His data cover 1979–93, and his results indicate that (1) long spells of company training have substantial effects on wages and (2) those effects do not depreciate—indeed, they are estimated to increase from 4.4 percent in the first year to 8.2 percent after 9 years. The effect of long spells of school-based training is not statistically significant, although it also does not appear to depreciate. Short spells of training, perhaps not surprisingly, have less consistent effects.

So far, this article has concentrated on whether training increases wages by a statistically significant amount, rather than discussing the economic significance of the increase. This approach reflects the emphasis in the papers presented. Another question is, "Considering training as an investment, how does the rate of return compare with that from other investments, such as schooling?" Harley Frazis and Mark Loewenstein investigate this question, using data from the 1979–2000 surveys of the NLSY79.[17] Their analysis is restricted to training at least partially paid for by the employer. (See question 21 in table 1; for years prior to 1988, Frazis and Loewenstein impute whether the employer pays for training.) Like Parent, Frazis and Loewenstein control for jobs by restricting their investigation to within-job wage changes.

Frazis and Loewenstein show that estimates of the effect of training are highly dependent upon the assumed functional form of the relationship between wages and training. They find that the best-fitting functional form is one in which the logarithm of wages increases proportionately with the cube root of training. Using linear hours instead of the cube root results in a drastic underestimation of the effect of training at typical values, which may explain the insignificant effects found in some of the aforementioned papers. Frazis and Loewenstein find that, in their base specification, the median positive value of employer-financed training of 60 hours increases wages by about 5 percent, which, when annualized, implies a rate of return of 159 percent.

Frazis and Loewenstein consider several explanations for this very high estimated rate of return. Correcting for promotions (for which the NLSY79 collected data in 1988–90 and 1996–2000), direct costs of training, and heterogeneity in wage growth (as well as in wage levels) reduces estimated rates of return to 30 to 40 percent. While this estimate is still several times estimated rates of return to schooling in the literature, Frazis and Loewenstein note that returns to training appear to vary across jobs: managers and professionals have higher rates of return than do blue-collar workers, for example. In the presence of such variation, estimated rates of return can be regarded as the return of training to the trained. However, they are likely to be greater than the return that could be realized by employees who did not receive training.

Frazis and Loewenstein's research highlights the strengths of the NLSY79 data set in studying training. The large sample size, the long length of the panel, and detailed survey data about other labor market information, such as promotions, allow for relatively precise estimation of the effects of training while controlling for confounding influences.

Mobility. The most prominent early article analyzing the empirical relationship between worker mobility and training was written by Lynch.[18] Using data from the 1979–83 surveys of the NLSY79, Lynch estimated the probability of leaving the first job as a function of tenure for individuals who have permanently left school. Her estimates show that young persons who received formal on-the-job training from their employer are less likely to leave their job, whereas those who participated in training obtained from for-profit proprietary institutions outside the firm are more likely to leave their job (although this latter effect is not statistically different from zero). These results are consistent with the human-capital model if one makes the straightforward assumption that on-the-job training provides firm-specific skills and off-the-job training provides general labor market skills.

Further analysis of how training affects worker mobility is provided by Loewenstein and James Spletzer, who use NLSY79 data from the 1988–91 survey years.[19] After controlling for individual and job characteristics, they find that individuals who have received company training have a job separation rate that is 8 percent lower than individuals without such training, and individuals who received school training (business school, apprenticeship, vocational or technical institute, or correspondence courses) have no differences in job separation probabilities relative to persons who did not receive school training. The mean job separation rate in Loewenstein and Spletzer's sample is 53 percent. Assuming that company training is more specific than general and that school training is more general than specific, these empirical results are consistent with the basic predictions about worker mobility from the human-capital model.

Loewenstein and Spletzer use their empirical findings to build on the predictions from the human-capital model. Because the returns to specific training are lost when a job match terminates, the model predicts that specific training should be selectively provided to workers who are less likely to leave the job. (Evidence supporting this theoretical prediction is mentioned shortly). If there is uncertainty about workers' future mobility, and if information about the quality of the employer-worker match is revealed over time, it may be optimal to delay training as a means of avoiding making a costly investment in a worker who may soon leave the firm. Such a decision to delay training may be optimal even though it entails forgoing the returns to training during the early part of the employment relationship. Loewenstein and Spletzer find that the NLSY79 data show a substantial amount of delayed training; for example, their estimates show that a similar proportion of workers get their first spell of training in their second year of tenure as in their first year of tenure.

As part of his research mentioned earlier, Parent found that both on-the-job and off-the-job training at the current employer reduced a worker's mobility, while training at previous employers appeared to increase mobility, although by a lesser magnitude. For workers with more than one spell of employment, it is possible to correct for bias caused by differences across workers in propensities to leave jobs. When Parent makes this correction, the effect of training at the current employer is strengthened.

It is interesting to flip the training-mobility relationship around and ask whether individuals with higher expected future job separation rates receive lower amounts of company training. This is the question asked by Anne Beeson Royalty, who uses NLSY79 data from survey years 1980–86 in her analysis.[20] She finds that a higher incidence of company-provided training is given to individuals with lower estimated probabilities of leaving the employer. Assuming that company training imparts firm-specific skills, Royalty's analysis shows that profit-maximizing employers target the provision of specific training toward those individuals who are less likely to leave.

General and specific training

Human-capital theory distinguishes between general human capital, which is useful at many employers, and specific human capital, which is useful only at the current firm. Researchers have associated types of training that raise wages at both current and future employers with general human capital, and types of training that raise wages only at the current employer with specific human capital. Furthermore, types of training that reduce mobility have been associated with specific training. Much of the empirical work in the training literature has taken advantage of the wealth of information in the NLSY79 data to explore the measurement and theoretical implications of general and specific training.

The findings reviewed in this article up to now present a fairly consistent fit between the theoretical human-capital model and the empirical training results. From her wage-level estimation, Lynch finds that wages are raised by on-the-job training from the current employer, but not from previous employers, whereupon she concludes that on-the-job training is primarily specific. She also finds that off-the-job training taken before the worker's tenure on the current job does raise wages, consistent with such training being primarily general. Lynch's analysis of mobility leads her to a similar conclusion: that on-the-job training is more specific, whereas off-the-job training is more general; Loewenstein and Spletzer's analysis of worker mobility finds similar results. The one study mentioned that does not slot nicely with the theoretical model is Parent's, which finds little difference between off-the-job and on-the-job training, with similar returns for training provided by current and previous employers (consistent with general training) and with both reducing mobility (consistent with specific training).

A detailed analysis of the costs and returns to training within and across jobs was conducted by Loewenstein and Spletzer.[21] The motivation for this study was to analyze questions in the NLSY79 that ask about who pays for the training (question 21 in table 1). Recall from the discussion of the human-capital model that there are two costs to employer-provided training: the direct costs, plus an indirect cost of lower wages during training. It is assumed that asking workers who pays for the training refers to direct costs only; it is a stretch to believe that noneconomists would think of indirect costs (lower wages due to reduced productivity) when answering this survey question. Loewenstein and Spletzer find that employers pay for 96 percent of formal company training spells. This percentage is not surprising, because formal company training almost surely has a large component of specificity and the human-capital model predicts that employers will share the costs of specific training with the worker. Loewenstein and Spletzer also show that employers pay for 42 percent of training spells in the aggregate category of "business school, apprenticeship, vocational or technical institute, and correspondence course." This aggregate category, referred to as *school training* in the discussion that follows, should have a large component of generality, and according to the human-capital model, employers should pay the direct costs of general training only if they can pass on the costs to workers by paying them lower wages during the training.

Loewenstein and Spletzer find no significant evidence that workers receiving employer-provided training—either general or specific—accept lower wages during the training period. While this finding may seem to contradict the human capital model, it is consistently found in the empirical

literature—for example, by Lynch and Parent, as well as by researchers using training data from employer surveys.[22] The most likely explanation for this anomaly is that it is due to differences between trained and untrained workers that are difficult to control for empirically. If workers who receive training have higher ability than workers who do not receive training, and if this higher ability is observable to the employer, but unobservable to the data analyst, then workers who receive training will have higher wages relative to workers who do not receive training. Even if training lowers the starting wage, as is predicted by the human-capital model, higher wages attributable to differences in ability may make a lower starting wage difficult to observe in the data when one compares wages of untrained workers with wages of workers receiving training.

The human-capital model predicts that if employers are paying both the direct and indirect costs of training, as the NLSY79 data suggest, employers should also be realizing some of the returns. The empirical strategy that Loewenstein and Spletzer use to test this prediction is to compare the return to training when a worker remains at the employer providing the training with the return to training when the worker moves to a new employer. Loewenstein and Spletzer find that the return to training received from a previous employer is higher relative to the return to training received from the current employer when the training is arguably more general. Lengermann reports a similar result for long spells of company training. In combination with the absence of a starting-wage effect, Loewenstein and Spletzer's analysis shows that employers pay for some of the costs of general training and receive some of the returns. This finding is at odds with the standard human-capital model, but can be reconciled with several theoretical modifications to that model. For example, minimum wages, liquidity constraints, or contract enforcement considerations can result in the employer sharing the costs and returns of general training.[23]

This evidence that employers share the costs and returns of general training has led researchers to seek additional questions that measure the generality of training. In 1993, for the first and only time, the NLSY79 included the question "How many of the skills that you learned in this training program do you think could be useful in doing the same kind of work for an employer DIFFERENT than [current employer]?" There are five possible responses to this question: (1) all or almost all of the skills, (2) more than half of the skills, (3) about half of the skills, (4) less than half of the skills, and (5) none or almost none of the skills. In follow-up research, Loewenstein and Spletzer analyze the 1993 NLSY79 data and find that 63 percent of workers receiving employer-provided formal training respond that "all or almost all" of the skills they learned at one employer are useful in doing the same kind of work for a different employer.[24] This finding suggests that the skills individuals are learning in their employer-provided training have a large general component.

Loewenstein and Spletzer estimate wage and mobility equations with the 1993 general and specific training data as the key explanatory variable. Their wage regressions show, first, that there is no systematic relationship between the degree of generality of the training and its wage return in the job that provided the training and, second, that the return to training received from previous jobs exceeds the return to training received at the current job, for all degrees of generality. If these results are compared with those from a similar specification using data on the type of training (question 20 in table 1) instead of on the degree of generality, then the first result holds, whereas the second result holds for school training, but not for company training. This finding leads Loewenstein and Spletzer to discuss the pros and cons of the two training measures. They hypothesize that the type of training data conveys different information than does the self-assessed generality of training data. For training to be truly general, not only must the skills be useful at other employers, but also, other employers must observe and value the generality of those skills. The generality-of-training question in the 1993 NLSY79 asks the individual's opinion about whether the skills learned in the training are useful elsewhere, but this is not equivalent to asking alternative employers about the transferability of skills. By contrast, the question on type of training not only proxies for the generality of the skills imparted by training, but also conveys information about how likely other prospective employers are to observe these skills. For example, school training might easily be certified for other employers to see its value, but it may be difficult for prospective employers to observe the usefulness of skills learned in company training. Such reasoning leads Loewenstein and Spletzer to speculate that information on the type of training may be preferable to a directly asked question as a measure of generality. However, as they suggest, the evidence for such speculation is limited, and the research community would benefit from asking the question on degree of generality in more than 1 year.

HUMAN-CAPITAL THEORY GAINED ITS PRESENT PROMINENCE in labor economics more than four decades ago. The simple human-capital model has empirically testable predictions regarding the relationships among wages, mobility, and training. Testing these predictions requires microdata with detailed longitudinal information on training, individual wages, and job mobility—data that were not available at the time human-capital theory was originally developed. As we celebrate the 25th anniversary of the NLSY79 cohort, we are not surprised that much of the empirical knowledge about worker training has come from analyses of the data in that survey.

But any good literature review raises as many questions as it answers, and this article has tried to highlight some of

the issues that could benefit from further analysis and enhancements to the questionnaire. Three specific topics warrant mention. First, there is new theoretical and empirical research into the topic of why employers appear to pay for general training, and the NLSY79 data are likely to play an important role in the continuing development of this literature. Second, training is not always a well-defined concept, and any survey's measures of the incidence and duration of training undoubtedly contain measurement error; analyzing the amount, consequences of, and statistical remedies for measurement error is a topic that is well worth exploring.[25] Finally, any distinctions there are among formal training, informal training, and learning by doing have been ignored in this article; the NLSY79 has asked questions regarding informal training, but economists have not yet studied the responses to those questions in depth.[26] □

Notes

[1] See Gary Becker, "Investment in Human Capital: A Theoretical Analysis," *Journal of Political Economy,* October 1962, pp. 9–49, and *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education* (Cambridge, MA, National Bureau of Economic Research, 1964); Theodore W. Schultz, "Investment in Human Capital," *American Economic Review,* March 1961, pp. 1–17; and Jacob Mincer, "Investment in Human Capital and Personal Income Distribution," *Journal of Political Economy,* August 1958, pp. 281–302.

[2] See David A. Jaeger, "Estimating the Returns to Education Using the Newest Current Population Survey Education Questions," *Economics Letters,* March 2003, pp. 385–94.

[3] The formal mathematical model was worked out by Masanori Hashimoto in "Firm-Specific Human Capital as a Shared Investment," *American Economic Review,* June 1981, pp. 475–82.

[4] This greater likelihood has been shown by many authors using many data sets. For example, see the analysis of the National Longitudinal Survey of the High School Class of 1972 (NLSHS72) data by Joseph G. Altonji and James R. Spletzer, "Worker Characteristics, Job Characteristics, and the Receipt of On-the-Job Training," *Industrial and Labor Relations Review,* 1991, pp. 58–79; the analysis of Current Population Survey (CPS) data by Norman Bowers and Paul Swaim, "Recent Trends in Job Training," *Contemporary Economic Policy,* 1994, pp. 79–88; the analysis of Panel Study of Income Dynamics (PSID) data by Greg J. Duncan and Saul Hoffman, "On-the-Job Training and Earnings Differences by Race and Sex," *Review of Economics and Statistics,* 1979, pp. 594–603; and the analysis of the NLSY79 data by the authors cited in the later sections of this article.

[5] Jacob Mincer, "On-the-job training: Costs, returns and some implications," *Journal of Political Economy,* October 1962, pt. 2, pp. 50–79.

[6] Jacob Mincer, *Schooling, Experience, and Earnings* (New York, Columbia University Press, 1974).

[7] Later research found that earnings profiles were better described by a *quartic* function of experience; see Kevin M. Murphy and Finis Welch, "Empirical Age-Earnings Profiles," *Journal of Labor Economics,* April 1990, pp. 202–29.

[8] See Boyan Jovanovic, "Job Matching and the Theory of Turnover," *Journal of Political Economy,* October 1979, pp. 972–90; Edward Lazear, "Agency, Earnings Profiles, Productivity, and Hours Restrictions," *American Economic Review,* September 1981, pp. 606–20; and Joanne Salop and Steven Salop, "Self-Selection and Turnover in the Labor Market," *Quarterly Journal of Economics,* November 1976, pp. 619–27.

[9] Greg J. Duncan and Saul Hoffman, "On-The-Job Training and Earnings Differences by Race and Sex," *Review of Economics and Statistics,* November 1979, pp. 594–603; and James N. Brown, "Why Do Wages Increase with Tenure? On-the-Job Training and Life-Cycle Wage Growth Observed within Firms," *American Economic Review,* December 1989, pp. 971–91.

[10] Lee A. Lillard and Hong W. Tan, "Private Sector Training: Who Gets It and What Are Its Effects?" *Research in Labor Economics,* vol. 13, 1992, pp. 1–62.

[11] Found at **http://www.nlsinfo.org/nlsy79/docs/79html/79text/training.htm**.

[12] As mentioned in footnote 1 of table 1, the training questions in 1988, 1996, 1998, and 2000 have a 2-year reference period, whereas the training questions in 1989–94 have a 1-year reference period.

[13] Lisa M. Lynch, "Private Sector Training and the Earnings of Young Workers," *American Economic Review,* March 1992, pp. 299–312.

[14] Jonathan R. Veum, "Sources of Training and their Impact on Wages," *Industrial and Labor Relations Review,* July 1995, pp. 812–26.

[15] Daniel Parent, "Wages and Mobility: The Impact of Employer-Provided Training," *Journal of Labor Economics,* April 1999, pp. 298–317.

[16] Paul A. Lengermann, "How Long Do the Benefits of Training Last? Evidence of Long Term Effects across Current and Previous Employers," *Research in Labor Economics,* vol. 18, 1999, pp. 439–61.

[17] Harley Frazis and Mark A. Loewenstein, "Reexamining the Returns to Training: Functional Form, Magnitude, and Interpretation," BLS working paper no. 367, *Journal of Human Resources,* forthcoming, spring 2005.

[18] Lisa M. Lynch, "The Role of Off-the-Job vs. On-the-Job Training for the Mobility of Women Workers," *American Economic Review Papers and Proceedings,* May 1991, pp. 151–56.

[19] Mark A. Loewenstein and James R. Spletzer, "Delayed Formal On-the-Job Training," *Industrial and Labor Relations Review,* October 1997, pp. 82–99.

[20] Anne Beeson Royalty, "The Effects of Job Turnover on the Training of Men and Women," *Industrial and Labor Relations Review,* April 1996, pp. 506–21.

[21] Mark A. Loewenstein and James R. Spletzer, "Dividing the Costs and Returns to General Training," *Journal of Labor Economics,* January 1998, pp. 142–71.

[22] See, for example, John M. Barron, Dan A. Black, and Mark A. Loewenstein, "Job Matching and On-the-Job Training," *Journal of Labor*

Economics, January 1989, pp. 1–19; and John M. Barron, Mark C. Berger, and Dan A. Black, "Do Workers Pay for On-the-Job Training?" *The Journal of Human Resources*, spring 1999, pp. 235–52.

[23] For recent studies on the growing literature of why employers may share the costs of, and returns to, general training, see John Bishop, "What We Know about Employer-Provided Training: A Review of the Literature," *Research in Labor Economics*, vol. 16, 1997, pp. 19–87; Daron Acemoglu and Jorn-Steffen Pischke, "Why Do Firms Train? Theory and Evidence," *Quarterly Journal of Economics*, February 1998, pp. 79–119, and "The Structure of Wages and Investment in General Training," *Journal of Political Economy*, June 1999, pp. 539–72; Alison Booth and Mark Bryan, "Who Pays for General Training? New Evidence for British Men and Women," discussion paper no. 486 (Bonn, Institute for the Study of Labor (IZA), 2002); and Alison Booth and Gylfi Zoega, "Is Wage Compression a Necessary Condition for Firm-Financed General Training?" *Oxford Economic Papers*, January 2004, pp. 88–97.

[24] Mark A. Loewenstein and James R. Spletzer, "General and Specific Training: Evidence and Implications," *Journal of Human Resources*, fall 1999, pp. 710–33.

[25] For an analysis of the extent of measurement error in training in an employer data set, see John M. Barron, Mark C. Berger, and Dan A. Black, "How Well Do We Measure Training?" *Journal of Labor Economics*, July 1997, pt. 1, pp. 507–28. For a start on the extremely complicated topic of statistical consequences of, and remedies for, measurement error, see Harley Frazis and Mark Loewenstein, "Estimating Linear Regressions with Mismeasured, Possibly Endogenous, Binary Explanatory Variables," *Journal of Econometrics*, November 2003, pp. 151–78, and the working-paper version of "Reexamining the Returns to Training."

[26] A first pass at analyzing these responses is Mark A. Loewenstein and James R. Spletzer, "Formal and Informal Training: Evidence from the NLSY79," *Research in Labor Economics*, vol. 18, 1999, pp. 403–38.