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ABSTRACT

Some of the few U.S. studies on the link between training and productivity have used a subjective measure of productivity or a measure of the productivity of the most recently hired worker relative to a fully trained worker, rather than output, labor productivity, total factor productivity, or value-added measures. Administered by the U.S. Bureau of the Census as a telephone survey to a nationally representative sample of private establishments with more than 20 employees in both the manufacturing and nonmanufacturing sectors, the National Center on the Educational Quality of the Workforce's National Employer Survey represents a unique source of information on how employers recruit workers, organize work, invest in physical capital, and use education and training in the workplace. What makes this survey different from most other training surveys is its ability to examine the impact that all these factors have on the output of establishments and the wages of workers. A total of 1,621 of the 2,441 eligible manufacturing establishments returned completed surveys. Findings of the manufacturing part of the survey indicate that most employers provide some type of formal training program. Employers who have adopted some characteristics of "high performance work systems" and have made large investments in physical capital or have hired workers with higher average educational level are more likely to train workers within their establishment. The determinants of the proportion of workers trained look similar to those of the probability of offering formal training. The type and source of training are important determinants of the impact of training on productivity. (Contains 25 references.) (YLB)

EQW WORKING PAPERS

Employer-Provided Training in the Manufacturing Sector: First Results from the United States

by

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Introduction

The importance of human capital as a determinant of workers' wages and firms' productivity has long been recognized (see, for example, Becker 1964 and Mincer 1962, 1974). The recent debate on the determinants of economic growth has also led to renewed attention on the role human capital formation plays in productivity and output growth (see, for instance, Barro 1989 and Mankiw et al. 1993). At the micro-level, human capital accumulation is viewed as an increasingly important determinant of rising wage inequality (see Freeman and Katz 1994) and declining relative productivity of establishments. Although the empirical literature on the impact of human capital on wages or per capita income is well developed, relatively little work has been done on the impact of human capital (especially firm-provided training) on firm productivity. This gap in the empirical literature has been driven by the lack of appropriate micro-establishment-level data on output and inputs such as education and training. This paper attempts to deepen the current debate on the role of human capital in productivity. Our observations are based on a new, unique survey of employers and their workplace practices and output: the National Center on the Educational Quality of the Workforce's National Employer Survey (EQW-NES), sponsored by the Office of Educational Research and Improvement of the U.S. Department of Education.

In the United States, employers have historically relied on formal school-based education followed by informal "learning by doing" on the job to obtain the necessary level of human capital required by their specific production technologies. This system, however, does not appear to be as successful as it once was in satisfying the human capital needs of employers. Employers today are looking for workers who have a broader and deeper general education than in the past so that they can adjust to the changing skills requirements associated with new technologies (especially computers) and workplace practices, such as just-in-time production, job rotation, and cross-training. Skills such as computer usage, teamwork, problem solving, communication, and quality control are not easily

learned informally on the job. Although the skill needs of employers have changed, the marketplace in the United States does not appear to be delivering a sufficient supply of workers with higher levels of skill (as indicated by the greater premium being paid for those with more education and skills). In other words, as discussed by Bishop (1994) and Lynch (1994), there is a potential market failure in the provision of more general training. Possible reasons for this market failure include the presence of large, fixed components in training costs that make training more expensive for smaller firms than for larger firms, capital market imperfections, and other institutional barriers. In addition, there may be under-investment in training because some firms are concerned about raiding by other firms of their trained workers, or because employee turnover is so high that employers are not able to recoup their training investments.

Constructing a picture of actual training and education practices of U.S. employers and observing how these practices affect productivity have not been easy for a variety of reasons. This paper briefly summarizes existing sources of information on U.S. employer training practices and what these sources indicate are the "facts" on the incidence of employer-provided training, determinants of employer-provided training, and the impact of this training on various measures of business performance. This paper then describes the EQW-NES and how this new survey sheds light on the "facts" and fills in some of the holes in our current understanding of the determinants and outcomes associated with education and employer-provided training in the United States.

Previous Evidence on Employer-Provided Training

As documented in several recent papers (Lynch 1992, Zemsky and Shapiro 1994, Barron et al. 1994, Spletzer and Loewenstein 1994), there is no consensus on the estimate of the incidence of formal and informal training across surveys, especially household-based surveys. This appears to be due to the questions used, to whom the questions refer, to the nature of the survey instrument, and when in the business cycle the surveys were administered. As Zemsky and Shapiro, Barron and colleagues, and Spletzer and Loewenstein discuss, it also does not appear possible to reconcile the different estimates on training incidence.

The recent U.S. Department of Labor 1994 survey of establishments and their training practices highlights another gap in the collection of information on training. This training survey found that more than 70 percent of establishments in the United States offer some type of formal training. Fifty percent of establishments offer formal skills training, while the remaining establishments offer formal training in programs such as new-hire orientation and occupational health and safety. At the same time, only 16 percent of workers in the 1991 Current Population Survey said they had ever received any type of formal training from their current employers. We are left with an apparent paradox: most firms state that they are offering training, while few workers appear to be getting it. A possible explanation of this apparent paradox is that, although most firms offer training, only a small percentage of their workers actually receive it. Therefore, determining who actually receives training within a firm may go a long way toward resolving this contradiction. Unfortunately, given the structure of previous surveys on employer-provided training, this has been difficult to do at a nationally representative level.

Using household-based surveys, it is possible to identify the personal characteristics associated with higher amounts of employer-provided training (see Lynch 1995 for a review of these surveys). In our review of household-based surveys, we found that better educated workers, managerial and professional employees, and workers employed in larger firms are

more likely to receive firm-financed training. Unfortunately, relatively few studies of employers have been able to examine the impact of technological investments or changing work structures and worker characteristics on the probability that employers will provide training to their employees.

Understanding the incidence and determinants of employer-provided training is only part of the story on the role of training in the labor market. The impact that training has on productivity and wages is clearly the bottom line that interests most employers and policy makers. Surveys that focus on identifying which firms are training and then link this information with productivity data, however, may be subject to several problems if training is measured at only one point in time. Firms that are currently training most heavily may also have the greatest training needs (owing, for example, to lower labor productivity). In other words, current training investments and productivity are potentially endogenous. At the same time, if firms are training large numbers of employees for substantial periods of time (owing to the introduction of new technology or new work organization), we would expect to see little or even a negative impact of this investment on current productivity. Here the impact of current investments in human capital looks similar to what is found in the adjustment costs literature on the impact of new investments in physical capital on output. Therefore, if we collect data on firms at a single point in time and observe that those firms that are training workers have lower productivity, we cannot necessarily conclude that investments in training lower productivity. Instead, what is required are measurements of both present and past investments in training. Obtaining longitudinal information on training investments and output would be the best way to handle these problems. In the absence of longitudinal data, however, some attempt in a cross-sectional survey to collect retrospective data on training would be important.

Finally, the unit of analysis is important when trying to determine the impact of employer-provided training or other human resource management (HRM) practices on output or profitability. There is a great degree of heterogeneity across employers in their HRM strategies. Within multi-establishment firms, however, there is probably almost as high a degree of variation in practices across establishments as there is across firms. Therefore, the appropriate level of analysis is at the establishment level. Unfortunately, although it is usually possible to collect information on establishment-level HRM practices, it is more difficult to collect financial or productivity information at the establishment level for firms with more than one establishment.

For these reasons, along with employer concerns about the confidentiality of financial data, there have been few studies in the United States on the impact of employer-provided training on productivity. Some of the few studies that do exist (e.g., Barron et al. 1994, Bishop 1994) on the link between training and productivity have used a subjective measure of productivity, such as: the question, "On a scale of 1 to 4, how has your productivity changed over the last year?" or a measure of the productivity of the most recent hire relative to a fully trained worker, rather than output, labor productivity, total factor productivity, or value-added measures. If output or sales are used, they are often data from the firm and not the establishment (e.g., Bartel 1989).

These studies have produced some interesting findings on the impact of training on productivity. For example, Bartel (1989) used data from a mailed national survey of establishments conducted in 1985 by the

Human Resource Management group at Columbia University's Business School. Data on HRM practices were obtained on about 600 establishments, but unfortunately, the survey had only a 6 percent response rate. Bartel then linked these data to Compustat data to obtain information on productivity and financial performance. However, since most of the establishments in this survey were part of multi-establishment firms, there is a discrepancy in the unit of analysis of inputs and outcomes—the Compustat data refer to the firm, not the establishment. This problem, along with the low overall response rate, limits the reliability of the productivity analysis. Nevertheless, Bartel found evidence that returns to training investments increase productivity about 16 percent. In a later study, Bartel (1992) examined a small longitudinal panel of manufacturing firms and found that lagged training investments, as opposed to current investments, yield positive effects on current productivity.

Barron and colleagues (1987) and Bishop (1994) also used data from the 1982 Employment Opportunity Pilot Project survey, and Bishop (1994) used data from the National Federation of Independent Businesses survey to examine the impact of training in the first three months of employment on subjective measures of productivity for recent hires in establishments. In these surveys, employers were asked to rate the productivity of their most recent hires at the start of the job and currently on a scale from 0 to 100 (where 100 equals the maximum productivity rating any employee in a defined position could attain). Neither of these surveys was a nationally representative survey of employers, and the questions refer to the most recent new hires and not all incumbent workers in the establishment. However, Bishop (1994) concluded that employer-provided training raises this productivity measure by almost 16 percent. It is important to note that this is not a rate of return to training investments in the usual sense, since the productivity measure is a subjective evaluation of performance.

In summary, there is a large gap in our knowledge of the incidence, determinants, and outcomes of employer-provided training. This gap includes discrepancies in the measurement of formal and informal training, who provides the training, training costs, the impact of training on establishment productivity, the dynamics of training investments and their impact on productivity and productivity growth, and the linkages between training and other HRM practices, such as recruitment and selection, compensation, new technology, and changing work organizations. The remainder of this paper attempts to bridge part of this gap.

The EQW National Employer Survey

The EQW-NES was administered by the U.S. Bureau of the Census as a telephone survey in August and September 1994 to a nationally representative sample of private establishments with more than 20 employees in both the manufacturing and non-manufacturing sectors. The survey represents a unique source of information on how employers recruit workers, organize work, invest in physical capital, and utilize education and training in the workplace. What makes this survey different from most other training surveys is its ability to examine the impact that all of these factors have on the output of establishments and the wages of workers (see Lynch and Black 1995 for a more detailed discussion of this survey and its results).

The survey over-sampled establishments in the manufacturing sectors and those with more than 100 employees. Public sector employees, not-for-profit institutions, and corporate headquarters were excluded from the sample. Although the survey excluded establishments with less than 20 employees (about 85 percent of all establishments in the United States), the sampling frame represents establishments that employ about 75 percent of all workers. Since the focus of our research was on the intersection between employer practices and employees' human capital experiences, we decided to concentrate on those establishments employing the most employees. The target respondent in the manufacturing sector was the plant manager. The survey was designed to allow for multiple respondents so that information could be obtained from establishments that kept financial information, such as the book value of capital or the cost of goods and materials used in production, at a separate finance office (e.g., at central headquarters). Computer-assisted telephone interviewing was used to administer each survey, which took about 28 minutes to complete.

The sampling frame for the survey was the Bureau of the Census Standard Statistical Establishment Listing file, one of the most comprehensive and up-to-date listings of establishments in the United States. The survey included establishments in both the manufacturing and non-manufacturing sectors. This paper focuses

on results from the manufacturing sector only, but another paper (Lynch and Black 1995) contains a complete discussion of the results for the entire sample. Of the 2,441 eligible manufacturing establishments contacted by the Census, 610 refused to participate in the survey. This represents a 75 percent response rate, which is substantially higher than that found in many other similar establishment surveys.[1] The usual reasons given by employers for why they would not participate were that they did not take part in voluntary surveys and that they were too busy. Probit analysis (available from the author on request) of the characteristics of non-respondents indicates that there was no significant pattern at the two-digit industry level in the likelihood of participating in the survey. The only group of employers slightly less likely to participate were manufacturing establishments with more than 1,000 employees.[2] Of the 1,831 manufacturing establishments that participated in the survey, not all respondents completed all sections of the survey by the interview cut-off date of October 1, 1994. The final number of completed surveys in the manufacturing sector was 1,621. This represents a 66 percent completed survey response rate. The results presented in the following sections refer to this final sample of 1,621 establishments (see Appendix A for more details on the response rates and Appendix B for the distribution of establishments by industry).

The Incidence and Distribution of Training

Tables 1 and 2 report the percentage of establishments by size and industry that provide any type of formal training program to their workers (see Lynch and Black 1995 for more details, including the incidence of training in the non-manufacturing sector). Overall, 75 percent of establishments in the manufacturing sector provide formal training programs to their employees. Formal training in the EQW-NES was defined as structured training offered at the establishment or at another location and that occurred during working hours or at other times. Respondents were provided with examples of formal training, such as seminars, lectures, workshops, audiovisual presentations, apprenticeships, and structured on-the-job learning. In the manufacturing sector, smaller establishments (20 to 49 employees) are much less likely than larger establishments (1,000 employees or more) to provide some type of formal training program (60 percent versus 98 percent, respectively). There is also substantial variation across industries, with chemicals, petroleum products, and primary metals industries much more likely to provide formal training (88 percent of establishments), and employers in the textile and apparel sector much less likely to provide formal training (61 percent). The survey also included questions on the incidence of informal training by employer. Virtually every employer in the manufacturing sector reported providing informal training (99 percent). There is little variation by size or industry in the incidence of informal training. Therefore, the remainder of the analysis in this paper focuses on the characteristics and impact of formal training programs.

On average, 70 percent of the formal training programs provided by employers occur during working hours. Only 3 percent of the employers in the survey reported that all formal training occurs outside normal working hours, and 52 percent of the employers reported that all formal training occurs during work hours. Although most training occurs during the workday, manufacturing employers do not rely solely on in-house expertise to provide this training. About 56 percent of all training programs are provided by in-house person-

Table 1
Training Incidence in Manufacturing Sector by Establishment Size†

Number of Employees	*Percentage with Formal Training*
Single Establishment: 20-49	59.8%
Multi-Establishement: 20-49	65.5%
Single Establishment: 50-99	73.7%
Multi-Establishment: 50-99	84.0%
100-249	86.4%
250-999	90.9%
1,000+	98.0%
All	75.0%

† Table data are weighted means.

nel; the rest are provided by a variety of sources. Table 3 provides a breakdown of the different outside sources of trainers and the percentages of employers using any one of these providers. The most common providers of training outside the establishment are equipment suppliers or buyers (78 percent). This group is followed by private consultants, technical and vocational institutions, two-year colleges, and industry associations. Relatively few manufacturing employers use other government-funded training programs (12 percent) or unions (7 percent) for their formal training programs.

Since the EQW-NES has detailed information on establishment characteristics, worker characteristics, and workplace practices, it is possible to see how these factors affect the probability of an establishment providing formal training programs. Table 4 presents logit estimates of the impact of these categories of variables on the probability of providing any type of formal training program. The establishment characteristics include: number of employees (categorized by five size classes, omitting establishments with more than 1,000 employees); a dummy variable equal to one if the establishment is part of a multi-establishment enterprise or firm; a dummy variable equal to one if

employment at the establishment has gone up over the past three years; a dummy variable equal to one if employment at the establishment has gone down over the past three years; and ten two-digit industry controls (the ten industrial groupings shown in Table 2). Because the survey also collected information on the book value of capital stock, it is possible to include the capital/labor ratio to see if employers with greater investments in physical capital are more or less likely to invest in the human capital of their employees.

Worker characteristics include: a dummy variable equal to one if the employer reported that more than 25 percent of workers were less than fully proficient in their current jobs; an establishment average educational level, which was constructed by the weighted average across five occupational categories of average years of education; the percentage of employees working at the plant for less than one year; a dummy variable equal to one if the employer reported that the skills required to perform tasks at the plant had increased over the past three years; the percentage of non-managerial workers using computers in their jobs; the percentage of employees who were minorities or women; a dummy variable equal to one if any part of the plant was unionized; and the percentage distribution of employment by five occupational categories (managerial and professional workers is the omitted category).

Table 2
Training Incidence in Manufacturing Sector by Industry†

Industry	*Percentage with Formal Training*
Food and Tobacco	75%
Textile and Apparel	61%
Lumber and Paper	76%
Printing and Publishing	78%
Chemicals and Petroleum	88%
Primary Metals	87%
Fabricated Metals	72%
Industrial Machinery, Electronic Equipment, and Instruments	74%
Transportation Equipment	77%
All Other Manufacturing	78%

† Table data are weighted means.

Finally, proxies for workplace practices include: a dummy variable equal to one if the employer reported using benchmarking or total quality management (TQM); a dummy variable equal to one if the employer allowed job sharing; the percentage of workers rotated across jobs; the percentage of workers in self-managed teams; the number of organizational levels within the plant; and the number of employees per supervisor (see Lynch and Black 1996 for mean values of all of these variables and a full presentation of all estimated coefficients). Although the original sample size of completed interviews in the manufacturing sector was 1,621 plants, the logit analysis uses a smaller sample of 890 establishments. This is because data are missing on several of the explanatory variables, especially the book value of the capital stock.

As shown in Table 4, plants that employ 20 to 49 workers are much less likely to provide formal training programs to their workers than are other establishments. The only marginally significant industry effect that remains after controlling for all other characteristics of the establishment is for the textile and apparel sector. Establishments in this sector are less likely to provide formal training, everything else constant. Finally, establishments with a higher capital/labor ratio are more likely to provide formal training programs.

Significant worker characteristics include the average educational level of the establishment's employees, the dummy variable on increased skills demand, and the proportion of workers who are production, technical, or clerical/sales workers. All of these factors raise the probability of providing formal training programs. Table 4 provides evidence on the complementarity of investments in education and employer-provided training. Establishments with more highly educated workers are also more likely to provide additional human capital to their employees. Not surprisingly, employers who report rising skill requirements are also more likely to provide formal training. What is interesting about this finding is that employers today are meeting rising skill requirements with the introduction of formal training.

Employers who use benchmarking or have introduced TQM into their plants are also more likely to provide formal training, everything else constant. Both TQM and benchmarking require workers to take on more responsibility for quality control and problem solving. These skills are probably more difficult for workers to acquire informally, so employers need to develop formal training programs to meet these skill needs.

In summary, most employers provide some type of formal training program, although there is substantial variation by size and industry in the probability of providing formal training programs. In particular, even after controlling for a variety of worker and establishment characteristics, the smallest employers are much less likely to provide formal training programs. Regardless of size, employers who have adopted some of the characteristics of "high-performance work systems" are much more likely to have formal training programs. In addition, employers who have made large investments in physical capital relative to the number of workers or have hired workers with higher average educational levels are more likely to train workers within their establishments. This suggests that employer-provided training is a complement to rather than a substitute for investments in physical and human capital.

Table 3
Sources of Training in Manufacturing Sector†

Source	*Percentage of Establishments*
Equipment Suppliers or Buyers	78%
Private Consultants	60%
Technical and Vocational Institutions	59%
Community and Junior Colleges	57%
Private Industry Councils or Other Industry Associations	55%
Four-Year Colleges or Universities	39%
Other Government-Funded Training Programs	12%
Unions	7%

† Table data are weighted means.

Table 4

Determinants of the Probability of Providing Formal Training Programs in the Manufacturing Sector†

Variable Names	*Estimate*	*t-test*
Log Capital/Labor	0.24	2.60*
Less Than 49 Employees	-1.55	-2.06*
50-99 Employees	-0.99	-1.36
100-249 Employees	-0.99	-1.41
250-999 Employees	-0.58	-0.84
Multi-Establishment	0.02	0.09
Average Education	0.42	1.86*
% Workers < 1 yr.	-0.01	-1.08
% Production Workers	0.04	1.76*
% Supervisory Workers	0.03	0.87
% Technical Workers	0.04	1.76*
% Clerical/Sales Workers	0.05	2.12*
Use Benchmarks	0.79	2.22*
Use TQM	1.70	5.42*
Industry Controls	yes	

Number of Observations = 890
Log Likelihood = -232.70
Pseudo R^2 = 0.3169

† Logit maximum likelihood estimates. Equation also includes a constant; dummy variables for employment changes over the past three years; a dummy variable equal to one for establishments reporting that more than 25% of their workers are not fully proficient; a dummy variable equal to one if skills demand has increased over the past three years; percentage of employees who are minorities; percentage of employees who are women; percentage of non-managerial workers using computers; dummy variables equal to one if unionized, have job sharing, have a research and development center somewhere in enterprise, or export principal product; birth year of establishment; percentage of workers in job rotation; percentage of workers in self-managed teams; number of organizational levels; and average number of employees per supervisor. Omitted categories for dummy variables include more than 1,000 employees, no change in employment over past three years, and percentage of managerial workers.

*Significant at the 10% level.

Source: Lisa Lynch and Sandra E. Black. 1996. "Beyond the Incidence of Training: Evidence from a National Employer Survey." EQW Working Paper WP35. Philadelphia, PA: National Center on the Educational Quality of the Workforce.

Determinants of the Proportion of Workers Trained

Earlier in this paper, we discussed how the proportion of U.S. employers who provide formal training programs was high, yet the proportion of workers who reported receiving any formal training from their employers was low. To address this apparent paradox, Table 5 presents tobit maximum likelihood estimates on the determinants of the proportion of workers within each establishment who receive formal training. The explanatory variables are the same as those used in Table 4. Table 5 allows us to see which employers not only provide formal training but also train "deeply." The determinants of the proportion of workers trained look somewhat similar to the determinants of the probability of offering formal training. Establishments using high-performance work practices, such as TQM and benchmarking, are more likely to train a higher proportion of their workers. This result is not surprising since most, if not all, workers need to be trained in order to implement a high-performance work system successfully. Establishments with a higher capital/labor ratio are also more likely to train a higher proportion of their workers, as are establishments with more highly educated employees. Therefore, investments in training are positively correlated with other human and physical capital investments. The major difference between Tables 5 and 4 is in the coefficients on establishment size. Smaller establishments do not appear less likely to train a higher proportion of their workers, conditional on training at all. In fact, establishments that employ 50 to 99 workers and those that are part of larger multi-establishment enterprises train a greater proportion of their workers.

Table 5

Determinants of the Proportion of Workers Trained in the Manufacturing Sector†

Variable Names	*Estimate*	*t-test*
Log Capital/Labor	0.03	2.81*
Less Than 49 Employees	0.03	0.48
50-99 Employees	0.11	1.81*
100-249 Employees	0.06	1.12
250-999 Employees	0.07	1.52
Multi-Establishment	0.09	2.75*
Average Education	0.04	1.60*
% Workers < 1 yr.	-0.0002	-0.15
% Production Workers	0.006	2.99*
% Supervisory Workers	0.01	2.65*
% Technical Workers	0.005	2.13*
% Clerical/sales Workers	0.003	1.34
Use Benchmarks	0.15	4.44*
Use TQM	0.18	5.36*
Have Job Sharing	-0.04	-1.23
Industry Controls	yes	

Number of Observations = 890
Log Likelihood = -551.72
Pseudo R^2 = 0.1794

† Tobit maximum likelihood estimates. Equation also includes a constant; dummy variables for employment changes over past three years; a dummy variable equal to one for establishments reporting that more than 25% of their workers are not fully proficient; a dummy variable equal to one if skills demand has increased over the past three years; percentage of employees who are minorities; percentage of employees who are women; percentage of non-managerial workers using computers; dummy variables equal to one if unionized, have job sharing, have a research and development center somewhere in enterprise, or export principal product; birth year of establishment; percentage of workers in job rotation; percentage of workers in self-managed teams; number of organizational levels; and average number of employees per supervisor. Omitted categories for dummy variables include more than 1,000 employees, no change in employment over past three years, and percentage of managerial workers.

*Significant at the 10% level.

Source: Lisa Lynch and Sandra E. Black. 1996. "Beyond the Incidence of Training: Evidence from a National Employer Survey." EQW Working Paper WP35. Philadelphia, PA: National Center on the Educational Quality of the Workforce.

Impact of Training on Productivity

Although it is interesting to establish the characteristics and determinants of employer-provided training, the bottom line from an employer's perspective is the impact this training has on productivity. Table 6 presents estimates, assuming a simple unrestricted Cobb Douglas production function, of the impact of human capital, controlling for a variety of other factors, on the log value of 1993 sales or shipments (see Lynch and Black 1996 for a more detailed analysis, including additional specifications of the production function using labor productivity as a dependent variable for both the manufacturing and non-manufacturing sectors).[3] Table 6 indicates that human capital investments have a significant impact on the productivity of establishments. For example, a 10 percent increase in the average educational level of an establishment's employees (about one more year of schooling) would raise productivity by 8.5 percent. The number of workers trained at two points in time (unfortunately, it is not possible to construct a stock of training variable, as we are able to do with schooling) does not appear to have a significant impact on productivity, but the percentage of formal training outside working hours does have a positive effect on productivity. Training conducted outside working hours is more likely to be longer in duration and to occur off site. This suggests that the type and source of training are important determinants of the impact of training on productivity.

Table 6

Determinants of Establishment Productivity in Manufacturing Sector†

Variable Names	*Estimated Coefficient*
Log Capital	0.25*
	(11.304)
Log Materials	0.26*
	(11.812)
Log Hours	0.47*
	(12.45)
Log Average Education	0.86*
	(2.028)
Log Number Trained 1993	-0.12
	(-1.294)
Log Number Trained 1990	0.09
	(0.994)
Percentage of Formal Training Outside Working Hours	0.002*
	(2.104)

Number of Observations = 821
Adjusted R^2 = 0.8387

† Unrestricted Cobb Douglas production function, dependent variable = log value of 1993 sales; t-tests in parentheses. Other control variables included in the estimation: constant; dummy variables for being part of a multi-establishment enterprise; use of grades, communication skills, or work experience in recruitment criteria; unionization; TQM; benchmarking; above capacity; below capacity; export primary product; research and development center; two-digit industry controls; birth year of establishment; percentage of capital equipment less than one year old; and percentage of capital equipment one to four years old.

*Significant at the 5% level.

Source: Lisa Lynch and Sandra E. Black. 1996. "Beyond the Incidence of Training: Evidence from a National Employer Survey." EQW Working Paper WP35. Philadelphia, PA: National Center on the Educational Quality of the Workforce.

Conclusions

This paper has attempted to bridge some of the gaps in our understanding of the determinants and impact of employer-provided training in the manufacturing sector in the United States. Most employers in manufacturing provide some type of formal training programs to their workers, although there is considerable variation in the incidence of training by size and industry. Employers who make larger investments in physical capital and hire workers with higher than average educational levels for their occupations are more likely to be training their workers, as are employers who have adopted high-performance work systems. There are positive payoffs to education and certain types of employer-provided training in the manufacturing sector. Although these results suggest that human capital plays an important role in the manufacturing sector in the United States, future research is needed to solidify these findings. Nevertheless, given the wealth of information in the EQW-NES survey on workplace practices and characteristics that has not been previously available in cross-sectional studies on productivity, the findings in this paper suggest an important role for human capital investments on productivity in the manufacturing sector.

Endnotes

[1] For example, Delany and colleagues (1989) had a response rate of 6.5 percent; Lawler and associates (1992) had a response rate of 32 percent; the National Federation of Independent Business survey in 1987 had a 25 percent response rate (see Bishop, 1994, for a review of this survey); the Small Business Administration survey of establishments in 1992 conducted by Barron and colleagues (1994) had a 50 percent response rate; and the National Organization Survey of Establishments in 1991 had a 50 percent response rate (see Knoke et al., 1993). Nationally representative surveys of establishments with response rates closer to the EQW-NES rate include the BLS 1994 Training Survey, which had a response rate of 70 percent, and a 1992 survey of 875 establishments with more than 50 employees conducted by the University of Massachusetts Center for Survey Research and described by Osterman (1994), which had a response rate of 65 percent.

[2] Establishments with more than 1,000 employees represent only a fraction of all establishments (0.1 percent), and we believe that our results are not overly skewed by this under-representation.

[3] Note that the sample size is smaller than that in Tables 4 and 5, owing to the high non-response rate in our survey to the question on the costs of goods and services (other than labor) used in the production of 1993 sales.

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APPENDIX A

EQW National Employer Survey: Response Rates†

Manufacturing Sector	Percentage	Number of Cases
Completed + All Partials‡	75.0%	1831
Completed + Workplace Partials	70.4%	1728
Completed Interviews	66.0%	1621

† Empirical analysis of the determinants of the probability of refusing to participate in the survey indicated that manufacturing establishments in the largest size category (1,000 employees or more) were slightly more likely to refuse to participate in the survey than establishments in all other size categories.

‡ Since all interviews had to be completed by the end of September 1994, some of the surveys were not totally completed. The survey was divided into two main sections (and allowed for multiple respondents)—the first on establishment sales and financial information and the second on employment practices. The bulk of the survey questions were contained in the employment practices section of the survey. Because we are interested in the linkages between practices and output, our analysis in this paper focuses on the completed interviews only.

APPENDIX B

Distribution of Sample by Industry in the Manufacturing Sector

Establishment Industry	Unweighted	Weighted
Food and Tobacco (SIC 20, 21)	5%	2%
Textile and Apparel (SIC 22, 23)	4%	2%
Lumber and Paper (SIC 24, 26)	6%	2%
Printing and Publishing (SIC 27)	5%	2%
Chemicals and Petroleum (SIC 28, 29)	6%	1%
Primary Metals (33)	6%	2%
Fabricated Metals (34)	5%	2%
Machinery and Computers, Electrical Machinery, and Instruments (SIC 35, 36, 38)	6%	4%
Transportation Equipment (SIC 37)	6%	1%
All Other Manufacturing (SIC 25, 30-32, 39)	6%	6%

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