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OF
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ABSTRACT

This paper presents an analysis of a unique data set containing measures of the time devoted to training during the first three months on a job and the productivity consequences of that training. The major findings derived from the analysis of the data on new hire training may be summarized as follows:

* Training investments in new hires are substantial even for jobs that are generally considered unskilled.

* Formal training provided by specialized training personnel accounts for only a small portion of the training received by new hires.

* Productivity rises substantially during the first year on the job.

* To fill jobs requiring a great deal of on-the-job training, employers prefer applicants who have previous relevant work experience, who are well educated and who have vocational training in a relevant field.

* Large establishments invest more in the training of their new hires than small and medium sized establishments because (1) they have lower turnover, (2) they have better access to capital markets, (3) the marginal product of an hour of training time is higher at large establishments and (4) training lowers turnover more substantially at large establishments.

* The elasticity of demand for training is below unity.

* When it is a binding constraint, the minimum wage lowers training investment by roughly 17 percent during the first 3 months on the job and productivity growth by 5 to 10 percent.

* Informal training by coworkers and training by watching others do the job appear to have a higher benefit cost ratio than informal training by management.

* Estimates of rates of return to training derived from this data should be treated with a great deal of caution. Nevertheless, **marginal rates of return to training appear to be quite high.**

* The estimated benefit cost ratio for formal training depends on how the model is specified. The productivity growth effects of formal training are bigger at large establishments. Formal training has significantly larger effects on wage growth than informal training. Formal rather than informal training significantly increases the worker's propensity to quit.
  Formal training's tendency to have larger effects on wage growth and quit rates than informal training probably results from the fact that formal training is better signaled to the labor market.

* The reported generality of training has no significant effects on the its marginal productivity or on the effects of training on turnover.

* When training is reported to be highly general, training has a larger effect on wage growth than when training is reported to be specific. Nevertheless, **training that is reported to be entirely general has much larger effects on productivity growth than wage growth implying that the labor market treats this training as if it were largely specific to the firm.**

These results provide support for the view that workers do not pay the full costs of general training and do not receive wage increases equal to the full productivity effects of general training. They also lend support to our hypothesis that the outcomes of training, particularly informal training, are poorly signaled to the labor market. Because other employers are unaware of its exact character and unable to assess its quality prior to making hiring decisions, training that is technically general often becomes effectively specific to the firm and employers choose to share the costs and benefits of investments in general training. The second hypothesized reason why shared financing of general training may be in the joint interest of employees and employers is the fact that young workers are typically liquidity constrained while employers are not.

ON-THE-JOB TRAINING OF NEW HIRES

> If the Germans had any secret weapon in the post-1973 economic difficulties, it is the technical competence of their work force, which is in turn the product of their apprenticeship system.
>
> --Limprecht and Hayes, 1982, p.139.

> I think that the Japanese education system is not very good.... employer training is much more effective.
>
> --Yutaka Kosai, President, Japan Center for Economic Research, 1989

> The heart of this new [flexible] manufacturing landscape is the management of manufacturing projects: selecting them, creating teams to work on them, and managing workers' intellectual development.
>
> --Ramchandran Jaikumar, 1986, p. 75.

A growing number of commentators are pointing to employer sponsored training as a critical ingredient in a nation's competitiveness. American employers appear to devote less time and resources to the training of entry level blue collar, clerical and service employees than employers in Germany and Japan (Limprecht and Hayes 1982, Mincer and Higuchi 1988, Koike 1984, Noll et al 1984, Wiederhold-Fritz 1985). In the 1983 Current Population Survey, only 33 percent of workers with 1 to 5 years of tenure reported having received skill improvement training from their current employer (Hollenbeck and Wilkie 1985). Analyzing 1982 NLS-Youth data, Parsons (1984) reports that only 34 to 40 percent of the young workers in clerical, operative, service and laborer jobs reported that it was "very true" that "the skills [I am] learning would be valuable in getting a better job." The payoffs to getting jobs which offer training appear to be very high, however. In Parson's study, having a high learning job rather than a no learning job in 1979 increased a male youth's 1982 wage rate by 13.7 percent. While the 1980 job had no such effect, the 1981 job raised wages by 7.2 percent when it was a high learning job rather than a no learning job.

If the payoffs to such jobs are so substantial, why aren't such jobs more common? If one were to put this question to an employer, he would point to the high turnover rates of youth as the primary reason why he cannot afford to train new employees more intensely. For American workers with less than one year of tenure, the probability of a separation in the next 12 months is 59 percent. Since comparably defined turnover is only 20 percent in the United Kingdom and 24 percent in Japan, national differences in turnover could be a major reason for the low levels of training investment in the US, if the employer's explanation is right (OECD, 1984, Table 33 and 34).

The theory of on-the-job training says, however, that if training is general, turnover propensities should not matter. The worker pays the full costs of the training and reaps the full benefits whether or not there is subsequent turnover, so the decision to undertake training should be independent of prospective turnover. The problem with the prediction that workers pay all of the costs of general training is that analyses of large representative data sets generally fail to confirm it. In Parson's (1985, table 7.6) study, when a youth reported that it was "very true" that "the skills [I am] learning would be valuable in getting a better job", his job paid on average 2.4 to 14 percent <u>more</u> than when the above statement was "not at all true" even with an extensive set of controls for schooling and academic achievement included in the model. Bishop and Kang (1988) have conducted another test of this hypothesis in the 1984 follow up of the High School and Beyond seniors by regressing the log of the deflated starting wage of the current or most recent job on indicators of the receipt of employer sponsored training. Here again, the jobs offering some training rather than none or which offer greater amounts of training paid <u>higher</u> starting wage rates even when a whole array of human capital characteristics were controlled. For females the positive effect of receiving training on the starting wage was statistically significant. Adding dummies for occupation and industry did not change the results appreciably.

It could be argued, however, that these findings do not constitute a decisive refutation of the proposition that workers pay all of the costs of general training. Hiring decision makers are probably better at assessing the ability of job candidates than econometricians who are limited to the information in the NLS or HSB data file. The positive association between wages and training arises, it could be argued, because workers who are highly able (in ways not observed by the analyst) are both paid more and also recruited for jobs that require large amounts of training.

Unobserved heterogeneity no doubt contributes to the positive association between training and starting wage rates, but to transform a large negative structural relationship into a statistically significant positive relationships just described, sorting of more able job applicants into high training jobs would have to be very powerful indeed. If such a selection process were operating, access to training should depend on ability factors that are visible to the analyst as well as on factors that are not visible to the analyst. Yet models estimated by Parsons and by Bishop and Kang failed to find large effects of ability proxies such as test scores, grades, and being a disciplined student on the probability of receiving training.

One possible explanation of these anomalous findings is that the training is specific and the employer is financing <u>all</u> of its costs. But standard models of the sharing of the costs of specific training do not predict that employers pay all of its costs and some of the new revisionist theories--Salop and Salop's (1976) adverse selection theory--predict that employers pay none of the costs of specific training. A specific training explanation of the these findings is particularly perplexing when to all outward appearances the training is largely general.

Empirical tests of the theory of on-the-job training have been severely hampered by the absence of data on the key theoretical constructs of the theory--general training, specific training and productivity growth. Data on wage growth and turnover have been used to test various propositions of the theory, but definitive results have been elusive because the large number of unobservables result in there being at least two explanations for any given set of phenomena (Garen, 1987). I hope in this paper to overcome some of the limitations of previous research by analyzing the first large-scale data set to contain measures of the time devoted to training activities during the first three months on the job, who does the training, the generality of training and the productivity of the employees both during and after the receipt of training.

The paper is organized as follows. The first section describes how the data has been collected and how the measures of worker productivity and of time devoted to new hire training were constructed. Section 2 presents tabulations of this data by occupation, establishment size, industry, previous relevant work experience, age and education. Section 3 contains a very simple theory of training investment and then offers a multivariate analysis of the determinants of training investment. Section 4 analyzes the effect of training on productivity growth of new hires focusing on how the impacts of training depend on who provides the training, the size of the establishment and the generality of the training. Section 5 examines the effect of training on wage growth during the first 2 years on the job and then compares these wage rate effects with the productivity effects estimated in section 4. Section 6 examines the effect of training on turnover and promotions. The paper concludes with a summary of the major findings and a discussion of how the findings may illuminate the causes of the lower levels of on-the-job training for new hires in the US than in Germany and Japan.

I. DATA ON TRAINING AND PRODUCTIVITY GROWTH

The analysis is based on data from a survey of 3,412 employers sponsored by the National Institute on Education (NIE) and the National Center for Research in Vocational Education (NCRVE) conducted between February and June 1982. The survey was the second wave of a two-wave longitudinal survey of employers from selected geographic areas across the country. The first wave was funded by the U.S. Department of Labor to collect data on area labor market effects of the Employment Opportunity Pilot Projects (EOPP). The survey encompassed 10 EOPP pilot sites and 18 comparison sites selected for their similarity to the pilot sites. The ES-202 lists of companies paying unemployment insurance taxes provided the sample frame for the survey. Because of the interest in low wage labor markets, the sample design specified that establishments in industries with a relatively high proportion of low-wage workers be over sampled. The tax paying units were stratified by the estimated number of low wage employees and the number of establishments selected from each strata was roughly in proportion to the estimated number of low wage workers at the establishments in that strata. Within strata the selection was random. The survey was conducted over the phone and obtained a response rate of 75 percent.

The second wave attempted to interview all of the respondents in the first-wave survey. About 70 percent of the original respondents completed surveys for the second wave. Most of the respondents were the owner/manager of small firms who were quite familiar with the performance of each of the firm's employees. Seventy percent of the establishments had fewer than 50 employees, and only 12 percent had more than 200 employees. In large organizations the primary respondent was the person in charge of hiring, generally the personnel officer. If the primary respondent was unable to answer questions about the training received by newly hired workers in the sampled job, that part of the interview was completed by talking to a supervisor or someone else with line responsibility.

The employers who received the full questionnaire were asked to select "the last new employee your company hired prior to August 1981 regardless of whether that person is still employed by your company." Only 2594 employers had hired someone in the time frame requested and these employers constitute the sample used in the study.

The respondent was asked to report how much time typical new hires for this job spent during the first three months of employment in four different kinds of training activities: (1) watching others do the job rather than doing it themselves, (2) formal training programs, (3) informal individualized training and extra supervision by management and line supervisors, and (4) informal individualized training and extra supervision by co-workers. For the sample of firms and jobs, the means for the typical worker were 47.3 hours watching others do the job (T_W), 10.7 hours for formal training programs (T_F), 51 hours for informal training by management (T_S), 24.2 hours for informal training by co-workers (T_C). A copy of the relevant portions of the questionnaire is available from the author.

A training time index was constructed by first valuing trainer and trainee time relative to that of workers with two years of tenure in that job and then combining the time invested in training activities during the first three months on the job. The employers reported that workers with two years of tenure in the job averaged between 22 and 50 percent (depending on occupation and other worker characteristics) more productive than new hires during their first three months on the job. This ratio was calculated for each job/worker category and used to place a relative value on coworker time devoted to training.[1] The management staff members who provide formal and informal training were assumed to be paid 1.5 times the wage of coworkers. Formal training involves four kinds of costs: development costs, facility costs, trainer time and trainee time. Sometimes, it is one-on-one and sometimes it is done in groups but since most of the establishments in this study are small, class size was probably small as well. Consequently, it was assumed that when all the costs of formal training other than the trainee's time are lumped together--development costs, training materials costs and the value of the trainer's time--they are about 25 percent greater than the time costs of the trainee.[2] When supervisors and coworkers are giving informal training to a new employee, the trainee is almost invariably directly involved in a production activity. Employers report that for informal training, the trainees are typically as productive while being trained as they are when working alone (Hollenbeck and Smith 1984). Consequently, informal training is assumed to involve only the investment of the trainer's time. Thus in units of coworker time the value of trainer time is:

(1) Valued Trainer Time = $T_C + 1.5*T_S + T_F$

In units of trainee time, the time the trainee spends not producing because of training activities is:

(2) Trainee Time = $T_W + T_F$

The total investment in training in trainee time units[3] is:

(3) Total Training Investment = $T_W + T_F + (T_C + 1.5*T_S + T_F)/RP$.

where

RP = the productivity of the average new hire during the first 3 months divided by the productivity of typical worker with two years' tenure

The arithmetic mean of this index is 209 hours, implying that the value of the time invested in training a typical new employee in the first three months is about 40 percent of the output that the trainee can produce working full-time during the first three months on the job.

The survey asked the employer (or in larger firms the immediate supervisor) to report on productivity of the <u>typical</u> individual hired in the job after two weeks, during the next 11 weeks and at the end of two years at the firm. The rating was made on a "scale of zero to 100 where 100 equals the maximum productivity rating any of your employees in (NAME'S) position can obtain and zero is absolutely no productivity by your employee." For the full data set at the mean values of these indexes of reported productivity were 49.0 for the first two weeks, 64.6 for the next 11 weeks and 81.4 at the time of the interview. The questions asking for a rating of the productivity of particular workers had a nonresponse rate of only 4.4 percent. Comparably defined nonresponse rates for other questions were 8.2 percent for previous relevant experience, 3.2 percent for age, 6.7 percent for education, 8.6 percent for time spent in informal training by supervisor, and 5.7 percent for a three-question sequence from which starting wage rate is calculated. The low-nonresponse rate implies that our respondents felt that they were capable of making such judgments and augur well for the quality of the data that results.

The interview questions about the productivity of recently hired employees do not measure productivity in any absolute sense and therefore are not comparable across firms or across jobs in a firm. Rather, they are intended as ratio scale indicators of the relative productivity of a typical (or a particular) worker at different points in their tenure at a firm. Under an assumption that these productivity indexes are proportional transformations of true productivity plus a random error, percentage differences in cell means of the productivity index will be unbiased estimators of percentage differences in true productivity. If the variations in the productivity scores assigned by supervisors exaggerate the proportionate variations in the true productivity, our estimates of percentage differences in productivity between two workers will be biased upward. Even though it is possible for a worker's true productivity to be negative, the scale was defined as having a lower limit of zero. Floors and ceilings on a scale typically cause measurement errors to be negatively correlated with the true value. If this is the case, then our estimates of percentage differences in productivity between two workers will be biased downward. This latter type of bias appears to be more likely than the former.

Further evidence that the proportionality assumption results in an understatement of percentage differences in productivity between individual workers doing the same job comes from comparing the coefficients of variation of productivity in this and other data sets. If pairs of workers who are still at the firm are used to construct a coefficient of variation for this data set, it averages .13 for sales clerks, clerical, service and blue collar workers. This estimate of the coefficient of variation is smaller than the estimates of the coefficient of variation for yearly output derived from analysis of objective ratio scale measures of output. These estimates were .35 for sales clerks, .144 for semi-skilled blue collar workers, .28 in craft jobs, .164 for workers in routine clerical jobs and .278 in clerical jobs with decision making responsibilities (Hunter, Schmidt and Judiesch 1988). This means that the estimates of the effect of training on productivity growth reported in this paper are probably conservative. The fact that the employer is reporting on the past productivity of particular employees may also generate biases in data but it is not clear how estimates of productivity growth rates might be influenced by this problem.

Estimates were also prepared of the short run productivity penalty that results when new workers are hired. This productivity penalty has two elements: the opportunity costs of trainer time and the lower output of the trainee resulting from the worker's lack of familiarity with the job and the time devoted to training. When expressed in terms of the opportunity cost of the time of a worker with two years of tenure at the firm, the new hire penalty during the first three months on the job is equal to:

(4) Productivity Penalty = 1 - NP

$$\text{(5)} \qquad NP = \frac{RP \cdot TP}{520} - \frac{T_C + 1.5 * T_S + T_F}{520}$$

where

NP = productivity net of training cost of typical new hire

TP = time attempting to produce.

There is some uncertainty about the correct way to aggregate training time and productivity growth effects, so three different estimates of the penalty are presented. The preferred "liberal" estimate of the penalty assumes $TP = 520 - T_W - T_F$. This estimate assumes there is no double counting of training costs: ie. that when the employers told us that new employees were 26 percent less productive than workers with 2 years of tenure, they were not factoring into that calculation the fact that about 11 percent of the new hires time was spent in a training activity which produced virtually no output (watching others and formal training). The conservative double counting estimate of training costs assumes that TP = 520. In other words, it is assumed that the lower productivity reported for new workers reflects in part that portion of their time devoted to formal training and watching others do the work. The ultra conservative estimate of the penalty uses the conservative double counting assumptions and also substitutes an average of RP and 1 for RP. This estimate assumes that the reports of productivity growth made by respondent employers exaggerates true productivity growth by a factor of 2.

II. Estimates of the Magnitude of On-the-Job Training in the First Three Months of a Job

We will begin by examining how the costs and consequences of initial on-the-job training vary by occupation, industry, establishment size, and the previous relevant job experience, age, and schooling of the employee. Multivariate models of the determinants of the length and intensity of training are presented in section 3 of the paper.

Occupation

The impact of occupation on the amount of on-the-job training typically received by a new employee is examined in Table 1. The first four rows of the table describe how the average number of hours devoted to four distinct training activities during the first 3 months after being hired varies by occupation. Even jobs that are thought to require little skill--service jobs--seem to involved a considerable amount of training during the first 3 months: an average of 33 hours of watching others, 5.7 hours of formal training, 35 hours of informal training by management and 17 hours of training by coworkers. Other occupations devoted considerably more time to training. The distribution of training activities was similar across occupations, however. The typical trainee spent most of his training time watching others do the job or being shown the job by a supervisor. Roughly equal amounts of time were spent in each. Informal training by coworkers is next most important and formal training provided by specialized training personnel accounted for an average of only 5 to 10 percent of the time new hires were engaged in a training activities.

The fifth row of the table summarizes this information into an estimate of investment in training during the first 3 months on the job. The index valued the time that managers, coworkers and the trainee devote to training and expressed it in terms of hours of trainee time. Training investment for service jobs was estimated to be 130 hours implying that the time invested in training a typical newly hired service worker in the first 3 months was equal in value to about 25 percent (130/520) of that worker's potential productivity during that period. Investments in training were considerably greater in other occupations. Retail (and service sector) sales and blue collar jobs had a mean index of 185 to 200 hours respectively or 35 to 38 percent of the new employee's potential productivity. Clerical jobs typically required the equivalent of about 235 hours of training or about 45 percent of the new worker's potential output. Professional, managerial and non retail sales workers required the equivalent of about 300 hours of on-the-job training or nearly 60 percent of the new worker's potential output.

TABLE 1
TRAINING AND PRODUCTIVITY GROWTH OF TYPICAL NEW EMPLOYEES BY OCCUPATION

	Profes-ssional	Mana-geral	Sales Not Retail	Retail Sales	Clerical	Blue Collar	Service
Hours Spent in Training in First 3 Months							
Watching others do the job	60.0	65.0	82.8	39.2	50.4	48.1	32.7
Formal training programs	9.1	12.1	23.9	8.2	13.5	9.1	5.7
Informal training by management	76.6	80.4	71.8	48.5	54.6	49.3	35.1
Informal training by co-workers	31.8	23.0	33.9	23.9	26.2	26.8	16.7
Investment in Training Time	293	295	350	185	235	200	130
Weeks to become fully trained if no previous experience	11.1	13.4	9.2	6.5	6.7	9.0	3.4
Increase in Reported Productivity (%)							
Betw. first 2 wks. & next 10 wks.	28%	32%	50%	30%	40%	32%	28%
Betw. first 3 mo. & end of year 2	38%	33%	56%	25%	32%	23%	17%
New Hire Productivity Penality as a % of Productivity of Wkr. with 2 Yrs. Tenure							
Liberal assumptions	69%	69%	74%	51%	60%	50%	39%
Conservative assumptions	58%	56%	59%	44%	50%	43%	33%
Ultraconservative assumptions	43%	43%	43%	32%	37%	30%	23%
Increase in Real Wage in First 2 Yrs. (%)	5.0%	7.7%	22.6%	9.7%	11.5%	11.5%	3.7%
Number of cases	95	112	76	203	429	649	334

NOTE: Sample is limited to jobs for which all the necessary questions on wage rates, training time, and productivity were answered.

The sixth row of the table reports the geometric mean of the answers to the question "How many weeks does it take for a new employee hired for this position to become fully trained and qualified if he or she has no previous experience in this job, but has the necessary school-provided training." Service jobs were reported to require an average of only 3 to 4 weeks of training, retail sales and clerical jobs slightly under 7 weeks, and professional and managerial over 10 weeks.[4]

This training seemed to have the hoped-for result of increasing the productivity of the new employees. The reported productivity of new employees increased quite rapidly (by roughly a third) during the first month or so at the firm (see row 7). Despite the much greater time interval, the percentage increases between the first quarter and the end of the second year (see row 8) were smaller than those during the earlier period for blue collar, service, clerical and sales jobs. For these occupations training investments and learning by doing seem to be large in the first few months on the job but to diminish rapidly thereafter. In the higher level, managerial and professional jobs, reported increases in productivity were larger between the third and 24th month than in the first few months. This reflects the more prolonged training period for these occupations. The occupations which devote the least time to training--the service occupations--were the occupations with the smallest increase in productivity with tenure. The reported productivity of service workers improved an average of 28 percent in the first month or so and a further 17 percent in the next 21 months. Occupations for which a lot of time is devoted to training in the first 3 months--professionals, clerical workers, managers and sale representatives outside of retail and service industries--also seemed to have larger than average increases in reported productivity as the worker gains in tenure. Clerical workers, for instance, were reported to be improving their productivity by 40 percent in the first month or so and by a further 32 percent by the end of the second year on the job.

These very rapid rates of productivity growth suggest that the ratio of the productivity increase to the costs of training (combining both worker and employer benefits and costs) may be extremely high during the first months of employment. For clerical workers the total costs of training during the first 3 months was 235 hours or .113 of a year's output by a worker whose skill level is equal to that of a new employee. Since this figure is an upper bound on the investment that contributed to the 40 percent gain during the first months on the job, the average gross rate of return must have been above 354% per year (.40/.113). Since the intensity of training investment falls with tenure at the firm, the cost of training investment during the next 21 months cannot have exceeded .7875 (1.75*235/520) of a year's productivity by a newly hired worker. This implies that the average gross rate of return to training investments during this 21 month period exceeded 40% per year (.32/.7875). However, marginal gross rates of return to training investment are lower and some of the gain in productivity results from learning by doing not training. Multivariate cross section models of productivity growth which yield evidence on the marginal productivity of training are presented in section 4 of the paper.

One of the consequences of the heavy investments in the training of new hires is that new employees make significantly smaller contributions to the firm's current output than other workers who have been with the firm for a couple of years or more. The time specifically devoted to formal and informal training activities is not the only penalty incurred when a new employee is hired. In most jobs, skills are developed and refined through practice. Learning by doing as it is called may not actually involve spending time away from a directly productive activity. It is costly, nevertheless, for the new worker is less productive than experienced workers. Thus the productivity penalty when a new worker is hired has two components: training investments and the lower productivity of the new worker and the time others devote to raising the new worker's productivity.

Estimates of the short run productivity penalty when a new worker is hired are presented in row 9-11 of the table. These numbers provide a rough guide to the magnitude of the adjustment costs associated with expansions carried out by hiring additional workers rather than by scheduling extra hours. The other major component of adjustment costs--recruitment and selection costs--tend to amount to only about 1 percent of a year's output by an experienced worker. The new hire productivity penalty is much larger. During just the first 3 months, it was equivalent in value for service workers to an average of about 1 months output by an experienced worker using conservative assumptions about double counting. For professional, managerial and sales representatives outside the retail and service sector, the penalty averaged about 1.65 months of output by experienced occupants of the job. The large magnitude of these costs helps explain why employers tend to hire new employees only when the increase in demand is perceived to be long lasting.

<u>Establishment Size</u>

The relationship between establishment size and training was curvilinear (see Table 2). The very largest and very smallest (10 or fewer employers) establishments invested the greatest amount of time in training. Managers spent 59 hours training the new employee at the smallest establishments and only 44 hours at establishments with 11 to 50 employees. The very smallest establishment invested 43 percent of a new hire's potential productivity (224 hours) during the

TABLE 2

TRAINING AND PRODUCTIVITY GROWTH OF TYPICAL NEW EMPLOYEE BY ESTABLISHMENT SIZE

	Number of Employees			
	0-10	**11-50**	**51-200**	**201+**
<u>Hours Spent in Training in First 3 Months</u>				
Watching others do the job	48.7	45.4	48.3	55.4
Formal training programs	11.8	7.4	9.2	17.0
Informal training by management	59.1	44.4	52.8	48.0
Informal training by coworkers	23.3	24.3	27.5	32.4
<u>Investment in Training Time</u>	224	1835	213	248
Weeks to become fully trained if no previous experience	8.1	6.4	6.1	8.3
<u>Increase in Reported Productivity (%)</u>				
Betw. first 2 wks. & next 10 wks.	29%	33%	37%	49%
Betw. first 3 mos. & end of year 2	26%	24%	26%	34%
<u>New Hire Productivity Penality as a % of Productivity of Wkr with 2 Yrs. Tenure</u>				
Liberal assumptions	55%	50%	55%	61%
Conservative assumptions	46%	42%	46%	51%
Ultraconservative assumptions	34%	30%	34%	37%
<u>Increase in Real Wage in First 2 Yrs.</u> (%)	12.1	7.3	8.7	9.6
Number of cases	792	678	296	123

NOTE: Sample is limited to jobs for which all the necessary questions on wage rates, training time, and productivity were answered.

first 3 months in training while the next largest size category (11-50 employees) invested only 35 percent of the new hire's time. Those with more than 200 employees invested 48 percent of the new hires time in training. The curvilinearity remains when other determinants of training are controlled. Reflecting the pattern of investment in training, wage increases also exhibited a curvilinear pattern being bigger in the very smallest and very largest establishments.

Reported increases in productivity did not, however, have a curvilinear pattern. Rather there was a consistent tendency for the reported increases in productivity to be larger at the larger establishments. The very smallest establishments reported a 29 percent productivity increase in the first few months and a further 26 percent increase by the end of the second year. The largest establishments reported a 49 percent increase in the first few months and a 34 percent increase during the next 21 months. Such a dramatic contrast between the pattern of training investments (input) and training outcomes is unusual. The relationship between training investment measured in time units (line 5 of Tables 1 - 5) and returns to that investment, the increase in productivity (line 7 or line 8) is described by:

$$(6) \quad \frac{P_{2YR}-P_{1Q}}{P_{1Q}} = \%\Delta P = AGROR_j(\Theta_j)(\text{Total Training Investment})$$

where

$AGROR_j$ is the average gross rate of return on dollars of investment in the training of stayers at the j^{th} establishment

Θ_j is the opportunity cost of training time at the j^{th} establishment

The lower percentage productivity growth to investment ratio of tiny establishments implies that either they have a lower AR_j or a lower Θ_j. It is unlikely that tiny establishments have lower $AGROR_j$ for they have higher turnover and poorer access to capital markets. The probable explanation of their small $\%\Delta P$ is a lower opportunity cost of time devoted to training (Θ_j). The opportunity cost of managerial, coworker and trainee time devoted to informal training are likely to be lower because small establishments are unable to spread the risk of stocastic demand as well as larger establishments and so must typically operate with a higher ratio of capacity (staff on hand) to demand (staff interacting with a customer or engaged in production). Scheduling of training is also probably more flexible so training can be done during periods of slack work when opportunity costs of trainer and trainee time are low.

TABLE 3
TRAINING AND PRODUCTIVITY GROWTH OF TYPICAL NEW EMPLOYEES
BY
PREVIOUS RELEVANT EXPERIENCE

Typical New Employees	None	Under 1 Year	1-3 Years	3-5 Years	5-10 Years	More Than 10 Years
Hours Spent in Training in First 3 Months						
Watching others do the job	49.8	53.6	47.0	39.3	43.6	35.4
Formal training programs	11.0	11.2	8.2	11.4	11.1	4.9
Informal training by management	51.7	60.9	47.0	43.9	56.7	41.6
Informal training by coworkers	26.9	27.1	24.1	19.5	21.2	18.7
Investment in Training Time	220	242	185	171	203	149
Weeks to become fully trained if no previous experience	6.3	7.0	6.7	9.1	8.6	11.1
Increase in Reported Productivity (%)						
Betwn. first 2 wks. & nest 10 wks.	37%	35%	27%	29%	29%	29%
Betw. first 3 mos. & end of year 2	30%	29%	21%	19%	21%	21%
New Hire Productivity Penality as a % of Productivity of Wkr with 2 Yrs. Tenure						
Liberal assumptions	56%	60%	48%	48%	51%	45%
Conservative assumptions	47%	50%	40%	40%	43%	38%
Ultraconservative assumptions	34%	36%	29%	29%	32%	27%
Wage Rate						
Current wage	$ 4.66	5.05	5.62	6.91	6.42	7.90
Increase in real wage	13.9	10.8	8.2	4.7	4.7	0.0
Number of cases	699	382	404	124	193	96

NOTE: Sample is limited to jobs for which all the necessary questions on wage rates, training time, and productivity were answered.

Relevant Work Experience

The association between training investments that are typically made in new hires and previous relevant experience of the individual actually hired is presented in Table 3. Jobs which were filled by new hires with less than one year of previous relevant experience, typically involve new hire training investment that was 45 percent of the new hire's potential productivity. For jobs filled by new hires with 10 years of previous relevant experience training investment averaged 29 percent of potential productivity. This occured in the face of a strong tendency for the jobs obtained by those with a great deal of relevant experience to be jobs that require a considerably longer training period (see line 5). Clearly when employers filled jobs that require a great deal of training if workers have no previous experience, they tended to give preference to candidates that because of their previous experience were less costly to train. Note also that jobs filled by new hires with greater previous relevant experience received substantially higher wage rates (see line 10).

The pattern of productivity and wage increase follow the pattern of investment. Those with the least experience started out considerably less productive but their productivity grew from this lower base at a faster rate. Their wage rates start lower but rise faster. The new hires with more than 10 years of previous experience, started out more productive and were paid a higher wage. Their productivity rose but at a slower rate and they received no increase in their real wage.[6]

Age

The association between the training normally given to new hires and the age of the new hire is described in Table 4. The relationship was curvilinear. The 25 to 29 year old age group appears to obtain jobs offering the greatest amount of training to typical new hires--235 hours. Teenagers typically entered jobs requiring about 206 hours and those over forty typically entered jobs requiring the least training--156 hours. Productivity growth and wage increases seem to follow an irregular pattern that was roughly curvilinear with a peak in the 20-24 age group. The average wage of a worker with 2 years of tenure in the firm was curvilinearly related to age with the peak in the 30 to 39 age bracket.

Schooling: Type and Amount

The relationship between type and amount of schooling of the new hire and the on-the-job training typically received by the typical occupant of the job is explored in Table 5.

TABLE 4
TRAINING AND PRODUCTIVITY OF TYPICAL NEW EMPLOYEES
BY AGE

Typical New Employees	**16-19**	**20-24**	**25-29**	**30-39**	**40+**
Hours Spent in Training in First 3 Months					
Watching others do the job	43.7	52.6	52.0	45.5	38.9
Formal training programs	8.9	7.8	17.2	12.1	2.9
Informal training by management	54.7	52.8	58.4	45.9	43.3
Informal training by coworkers	23.8	29.4	23.1	23.3	20.4
Investment in Training Time	206	220	235	192	156
Weeks to become fully trained if no previous experience	5.6	7.4	7.4	8.2	7.0
Increase in Reported Productivity (%)					
Betwn. first 2 wks. & nest 10 wks.	33%	38%	30%	31%	28%
Betw. first 3 mos. & end of year 2	27%	29%	24%	23%	23%
New Hire Productivity Penality as a % of Productivity of Wkr with 2 Yrs. Tenure					
Liberal assumptions	53%	37%	56%	51%	46%
Conservative assumptions	45%	47%	46%	42%	39%
Ultraconservative assumptions	33%	34%	34%	32%	28%
Wage Rate					
Current wage	$4.12	5.25	5.84	6.20	5.80
Increase in real wage	11.8	12.1	9.3	7.5	3.6
Number of cases	346	582	409	332	229

NOTE: Sample is limited to jobs for which all the necessary questions on wage rates, training time, and productivity were answered.

One would expect schooling to be positively related to the rate at which a new hire can learn new skills. This led to a hypothesis that employers would tend to select the better educated job applicants for jobs that require a great deal of training. When the job being filled requires a great deal of training if the new hire has no experience, we would also expect employers to attempt to reduce training costs by giving preference to the graduates of relevant vocational training programs.

Both of these hypotheses were supported by the data. People with more schooling and with relevant vocational training in school took jobs that have longer training periods for inexperienced workers and that offer more intensive training during the first three months on the job. High school drop outs with no vocational training typically got jobs in which training investments in the first 3 months are only 22 percent of the new hire's potential productivity. Graduating from high school raised the training that was typical for the job to 38 percent of the new hire's potential productivity. Getting vocational training in high school raised training that was tuypical for the job to 47 percent of potential productivity and vocational education at a 2 year college or technical institute raised it further to 52 percent. College graduates with a liberal arts degree got jobs typically requiring only slightly more training during the first 3 months on the job--54 percent of their potential productivity. College graduates who concentrated on vocational subjects such as engineering or business entered jobs offering the greatest amount of on-the-job training to typical new hires--56 percent of a much higher potential productivity.

Productivity growth with tenure seemed to be greatest in jobs normally filled by workers with many years of schooling. While productivity increases for vocational program graduates with 12 or more years of schooling were respectable, graduates of non-vocational programs generally had slightly higher rates of productivity increase despite their somewhat smaller amounts of training investment. The productivity of vocational program graduates probably grew more slowly because they started from a higher base. Evidence for their starting from a higher base is provided by the higher wage rates they were able to command. Graduates of high school vocational programs entered jobs with 10 percent higher wage rates than high school graduates that did not specialize. For those with 13 to 15 years of schooling the wage premium of the jobs which hired vocational graduates was 16 percent. College graduates with degrees in engineering, business or some other vocational subject received a 41 percent higher wage than liberal arts graduates in this data set.

TABLE 5
TRAINING AND PRODUCTIVITY GROWTH OF TYPICAL NEW EMPLOYEES
BY
SCHOOLING

	LT 12		12		13-15		16+	
Typical New Employees	Voc Ed	No Voc Ed	Voc Ed	No Voc Ed	Voc Ed	No Voc Ed	Voc Ed	No VocEd
Hours Spent In Training In First 3 Months								
Watching others do the job	30.2	25.6	56.4	45.6	61.3	49.0	84	67.1
Formal training programs	4.5	5.4	17.3	7.3	19.3	15.7	10.7	8.3
Informal training by management	40.0	31.6	53.4	54.0	62.4	51.7	68.7	68.9
Informal training by co-workers	23.8	17.3	31.3	23.5	26.4	23.8	27.1	23.9
Investment in Training Time	158	116	246	199	269	226.5	293	279
Weeks to become fully trained if no previous experience	6.5	4.2	9.7	6.3	11.1	7.3	12.4	11.3
Increase in Reported Productivity (%)								
Betw. first 2 wks. & next 10 wks.	33	24	28	35	34	38	35	37
Betw. first 3 mo. & end of year 2	33	17	28	24	28	30	33	41
New Hire Productivity Penality as a % of Productivity of Wkr with 2 Yrs. Tenure								
Liberal assumptions	51	36	58	52	63	58	68	70
Conservative assumptions	45	31	48	44	51	48	54	58
Ultraconservative assumptions	45	31	48	44	51	48	54	58
Wage Rate								
Current wage	$ 4.20	4.26	5.68	5.16	6.19	5.35	7.65	5.37
Increase in real wage	17.1	9.2	11.3	8.7	10.6	13.6	8.9	7.9
Number of cases	46	154	284	823	134	205	47	105

Note: Sample is limited to jobs for which all the necessary questions on wage rates, training time, and productivity were answered.

III. The Determinants of Training

The amount of training that is provided to typical new hires (I_j) is influenced by characteristics of the job and the firm which influence the increase in worker productivity resulting from training investments (X_j), the cost of capital to the firm and the worker (r_j), the rate of obsolescence of skills (δ_j), the separation rate (s_j), the share of training that is effectively specific to the firm ($1-g_j$), and the opportunity cost of training time (Θ_j). Let us assume that the impact of training investment on the hourly productivity of a worker can be represented by the following:

(7) $$P_j = f(X_j)I_j^{a} \qquad \text{where } 0 < a < 1$$

(8) $$\frac{\partial P_j}{\partial I_j} = P'(I_j) = af(X_j)I_j^{a-1}$$

The present discounted value of future productivity gains from training a worker who works H_j hours per month is a perpetuity that is discounted at a rate reflecting the cost of capital, obsolescence, the firm specificity of the skill and turnover. It can be expressed as:

(9) $$PV(I_j) = H_j{*}P_j\sum_{t=0}^{\infty} e^{-[r_j+\delta_j+(1-g_j)s_j]t} = \frac{H_jP(I_j)}{r_j+\delta_j+(1-g_j)s_j}$$

(10) $$\frac{\partial PV_j}{\partial I_j} = \frac{H_jP'(I_j)}{r_j+\delta_j+(1-g_j)s_j}$$

Since the marginal productivity of training declines as training increases, the level of training investment is determined by the point at which the marginal cost of training investment (Θ_j) is equal to the discounted value of its future marginal products («PV_j/«I_j).

(11) $$\Theta_j = \frac{H_jP'(I_j)}{r_j+\delta_j+(1-g_j)s_j} = \frac{H_j[af(X_j)I_j^{a-1}]}{r_j+\delta_j+(1-g_j)s_j}$$

Taking logs and solving for the level of investment, we have:

(12) $$\ln(I_j) = \frac{1}{a-1}[\ln[r_j+\delta_j+(1-g_j)s_j] + \ln(\Theta_j) - \ln(H_j) - \ln(f(X_j)) - \ln(a)]$$

Two different indicators of training investment are analyzed in this multivariate framework. The answer to the question, "How many weeks does it take for a new employee hired for the position to become fully trained and qualified if he or she has no previous experience in this job but has the necessary school-provided training?" is the first indicator studied. It is a measure of the length of the training given new employees. The second is a measure of training intensity--the value of the time devoted to training during the first 3 months of a worker's tenure at a firm. Table 6 presents the results of the regressions predicting the logarithm of the two measures of training investment. Multiplying a coefficient by 100 gives a rough estimate of the percentage impact of a right-hand-side variable.

Both of the measures of training analyzed are indicators of the resource cost of training a particular individual and not of the learning that has occurred as a result of the training. Most of the determinants of training that are available in the data set are indicators of demand for and the payoff to training or are variables that influence both the payoff and costs of training. Factors that raise the payoff to training will increase both the cost of training (input) and the learning (output) that results. When one looks across jobs, theory and previous empirical work predict that on-the-job training is complementary with capital, complementary with the skill level of other workers in the firm, and complementary with previous general and occupationally specific training of new hires. All of these hypotheses are supported. Workers who use expensive machinery typically receive a greater amount of training than other workers. The elasticity of response is .066 for training intensity and .081 for weeks to become fully trained and qualified. The skill level of other workers seems to have a positive effect on training. Evidence of this is the large positive effect that the proportion of the work force in skilled occupations (white-collar or craft) has on training.

Jobs for which previous school-provided vocational training is important in selecting new hires tend to involve much more training on-the-job than jobs for which previous school-provided training is not important. Jobs that are considered to require an extensive general educational background also typically involve longer periods of on-the-job training. These results imply that students who take more years of schooling and who obtain vocational training typically find jobs that offer greater on-the-job training as well. When jobs requiring a great deal of training are filled, employers seem to be particularly interested in hiring applicants with a strong educational background and relevant occupational training.

It is generally thought that very large establishments invest more training because the discounted value of future payoffs to training is higher due to lower turnover (s), lower required rates of return (r) (resulting from better access to capital markets) and lower marginal training costs due to economies of scale (one trainer can teach many workers simultaneously). The results presented in Table 2 suggests the following additional, hypotheses, regarding training investments at establishments with fewer than 10 employees. New hires in very small establishments are hypothesized to spend more time in training than new hires at medium sized establishments for two

Table 6

THE DETERMINANTS OF THE TRAINING OF THE TYPICAL NEW HIRE

Characteristics	Log Weeks to Become Fully Trained		Log Training Intensity In First 3 Months	
Job Characteristics				
Importance of voacational education	.384***	(3.72)	.522***	(5.58)
Specific vocational preparation	-.020	(.67)	-.009	(.31)
General educational requirements	.176**	(2.53)	.067	(1.37)
Clerical	-.257**	(2.06)	.250**	(2.21)
Sales	.046	(.27)	.645***	(4.26)
Retail Sales	.038	(.21)	-.344**	(2.11)
Professional	-.082	(.43)	.121	(.71)
Managerial	.073	(.39)	.066	(.63)
Service	-.332***	(2.83)	.076	(.71)
Craft	.136	(1.19)	.066	(.63)
Log cost of machine	.081***	(3.87)	.066***	(3.49)
Hours per weeks	.0161***	(3.82)	.018***	(4.58)
Temporary job	-.344***	(3.63)	-.295***	(3.54)
Starting wage	.023	(1.55)	-.035***	(2.64)
Wage at or below legal minimum	-.072	(.85)	-.170**	(2.22)
Employer Characteristics				
Log established employment	-.206**	(2.19)	-.317***	(3.72)
Log employment squared	.0273**	(2.17)	.049***	(4.25)
Log ratio firm/establishment employment	-.016	(.60)	.038	(1.60)
Proportion skilled	.452***	(3.76)	.470***	(4.31)
Proportion craft	.302*	(1.92)	-.127	(.89)
Proportion under 25	-.088	(.70)	.237**	(2.07)
Proportion union	-.155	(1.18)	-.114	(.96)
Sales growth last 2 years	-.858***	(2.70)	-.058	(.20)
Sales growth last 2 years if positive	.962***	(2.70)	.065	(.20)
Employment Growth	-.035	(.17)	-.041	(.22)
Past employment growth if positive	-.306	(.99)	-.270	(.97)
Market Characteristics				
Log alter employers using same skills	-.016	(.79)	-.049***	(2.63)
Log labor market size	.017	(.62)	.042*	(1.70)
Standard error of estimate	1.257		1.14	
R squared	.182		.159	
Number of observations	1659		1659	

reasons. First, their employees must be taught a broader range of skills because very small establishments have much more limited scope for division of labor. Secondly, the opportunity costs of informal training time are lower because it can be scheduled during slack periods (e.g., when no customers are in the store) and these periods are more frequent in very small establishments. Multivariate analysis supports the hypothesis that the size of an establishment exerts a non-linear effect on the time that is devoted to training. Large establishments devote more time to training new employees than very small establishments, but they in turn devote more time than medium sized establishments. The establishment size which has the minimum level of training is 25 employees for training intensity and 43 for length of training. Being a part of a multi-establishment firm has no significant impact on training time.

High rates of turnover reduce the payoff to training, so we would expect it to be associated with lower levels of training investment per worker and to do so particularly when training is specific to the firm. Endogeneity prevents our using average rates of turnover as a regressor, but variables measuring exogenous determinants of turnover are available. As predicted, temporary jobs offer significantly less training. Models estimated in this data have found that turnover is higher when there are many other local employers which make use of the same skills being taught in the job. As predicted, such jobs offered less training.

Full-time jobs offer more training. If one assumes that hours worked per week are exogenous (ie. hours effects but is not effected by the amount of training), the elasticity of demand for training with respect to changes in its marginal payoff can be calculated from the coefficient on weekly hours of the job. At the mean number of weekly hours in the sample of jobs, the elasticity estimate is -.7 (significantly below 0 and significantly greater than -1), implying that the demand for training with respect to its rental cost is inelastic. This means that a government subsidy equal to 10 percent of the full marginal opportunity costs of training (or a reduction in turnover or required rates of return which had an equivalent impact on rental cost) would increase time devoted to the training of each new hire by 7 percent. An inelastic demand for training also means that holding the job constant, a decrease in learning efficiency (eg. because the workers hired are slow learners or the firm is not very effective in its training) simultaneously increases the time devoted to training and reduces it's value added. The analysis finds support for this prediction because the employers who reported that it was "difficult to find reliable unskilled workers" and who hired many workers under the age of 25 did indeed spend significantly more time training new hires than other firms.

A number of economists have argued that because the minimum wage prevents workers from agreeing to a low wage rate during training, it discourages on-the-job training of inexperienced and unskilled workers (Hashimoto 1982, Leighton and Mincer 1981). Direct measures of OJT have not been available, however, and the indirect tests of the hypothesis using wage growth outcomes as a proxy for training can not be considered conclusive. The hypothesis implies that holding the skill requirements of a job constant, there is a reversal in the sign of the relationship between wage rates and training at the minimum wage. Above the minimum wage where wage rates are unconstrained, lower wage rates are associated with more training. The negative effect of the minimum wage on the intensity of entry level training should be visible in the jobs whose starting wages are at or below the $3.35 minimum that prevailed in 1983.[5] Many of these jobs will have had to be redesigned to minimize the costs of initial training. This might be accomplished by assigning the individual to a very narrow job and teaching only what is absolutely essential to achieve acceptable performance in that job. Training in other tasks might be postponed and spread over a longer period of time. These hypotheses were tested by including continuous measures of the wage rate and a dummy variable for wage at or below the minimum in the training models. As hypothesized, both of these variables had significant negative effects on training intensity and no significant effects on the length of training. Similar models predicting productivity growth were estimated (without including training investment on the right hand side) and the dummy for minimum wage constraint had a significant negative effect (-10 percent) in the linear specification and a small (-4.7 percent) non-significant negative effect in the logarithmic specification (Bishop 1985 Table 6.2).

IV. Impact of Training on Worker Productivity

New employees experience dramatic increases in productivity in the first 2 years of employment at a firm. A part of this productivity increase is due to learning by doing and would occur even if no training is provided. Formal and informal training is responsible for a major portion of the productivity growth, however. In this section, an effort will be made to determine which training methods are most effective and to measure the rate of return to training investments.

The 1982 Employer Survey distinguished four different types of employer-provided training: (1) formal training (provided by a training professional), (2) time spent watching others do the job, (3) informal on-the-job training by supervisors, and (4) informal on-the-job training by co-workers. The impact of training on productivity growth of typical new employees was estimated by regressing productivity growth during the first 2 years on the hours spent in each training activity, the duration of training and a vector of control variables. Since diminishing returns are to be expected, the square of the total cost of training was included in the model. Productivity growth during the first 2 years was defined in 2 different ways: the log of the productivity growth ratio and the change in productivity ratings on a 0-100 scale.[6]

The measures of time spent in specific training activities in the first 3 months on the job are measures of training intensity rather than of aggregate training investment during the first 2 years on the job. Consequently, the reported required length of training--the log of the weeks before a new employee becomes fully trained and qualified--was also included in the model. A full set of controls for job, occupation, and firm characteristics was included in each model. With the exception of the wage rate and minimum wage variables, the control variables used were identical to the independent variables used in table 7. The specification used was the following:

(13) $$P_{2YR}-P_{2WK} = \underline{AX} + a_1 \mathit{ln}L + a_2T_F + a_3T_S + a_4T_C + a_5T_W + a_6T^2 + u$$

where $\underline{X}$ = a vector of control variables listed in Table 3 ($\underline{A}$ is a vector of coefficients on these control variables)

$\mathit{ln}L$ = logarithm of the required length of training

T_F = Hours devoted to formal training during the first 3 months ('00s).

T_S = Hours spent in informal training by supervisors during the first 3 months ('00s).

T_C = Hours spent in informal training by coworkers during the first 3 months ('00s).

T_W = Hours spent training by watching others do the work during the first 3 months('00s).

T = Training Intensity is a weighted sum of the four different types of training where the weight reflect the assumed costliness of this form of training.
$T = 1.8{*}T_F + 1.5{*}T_S + T_C + .8{*}T_W$.

P_{2YR} = Productivity of the typical worker at the end of 2 years. In the linear models P_{2YR} is the productivity rating on the 0 to 100 scale divided by 80, the mean productivity rating for workers with two years of tenure. In the logarithmic models, P_{2YR} is the logarithm of the productivity rating plus 5.

P_{2WK} = Productivity of the typical worker during the first 2 weeks. In the linear models P_{2WK} is the productivity rating on the 0 to 100 scale divided by 80, the mean productivity rating for workers with two years of tenure. In the logarithmic models, P_{2WK} is the logarithm of the productivity rating plus 5.

The results are reported in Table 7. The regression with the logged productivity growth as dependent variable is in column 1. Regressions predicting the linear measure of productivity

Table 7
Impact of Training on Wage and Productivity Growth

	Productivity Growth			Wage Growth (log)	
	Typical Worker (log 2 Yrs.)	Typical Worker (linear 2 Yrs.)	Particular Individual Linear (1.1 Yrs)	Typical (2 Yrs)	Particular Individual (1.1 Yrs)
Ln Length of Training	.068*** (6.43)	.032*** (6.09)	.025*** (4.36)	.010*** (2.84)	.008**(2.49)
Hrs. of Training in first quarter					
Formal Training (100's)	.133*** (3.06)	.046** (2.14)	.048** (2.10)	.043*** (3.13)	.027**(2.05)
Training by Supervisors (100's)	.130*** (3.85)	.067*** (4.01)	.043** (2.44)	.020* (1.83)	.017 (1.61)
Training by Co-workers (100's)	.145*** (4.92)	.077*** (5.30)	.057*** (3.70)	.001 (.15)	-.002 (.25)
Watching Others (100's)	.149*** (7.37)	.053*** (5.30)	.046*** (4.32)	.017** (2.54)	.016** (2.55)
Training Intensity Squared (10,000's)	-.0085** (2.27)	-.0049** (2.61)	-.0050* (2.53)	-.0011 (.92)	-.0011 (.97)
Standard Error of Estimate	.597	.295	.308	.187	.178
R^2	.171	.129	.135	.198	.233
Number of Observations	2116	2116	2002	1986	1963

* Significant at the 10% level (two-sided)
** Significant at the 5% level (two-sided)
*** Significant at the 1% level (two-sided)

growth are in columns 2 and 3. In both models, the coefficient on the square term is negative and statistically significant indicating that there are diminishing returns to training intensity. When the square of total training intensity is included in the model, all four of the linear terms for a particular form of training have positive and statistically significant effects on productivity growth. The effect of training intensity on productivity is quite large. An increase in any of the training activities from 0 to 100 hours raises the worker's productivity by 13 to 15 percent in the logarithmic models and by 4 to 7.7 percent (calculated at the mean level of productivity at the end of two years) in the linear models. Clearly when training intensity is low, increases in its intensity will produce large increases in worker productivity.

The total effect of training on productivity growth was calculated by multiplying the six estimated coefficients by mean values of the corresponding variables. The calculated increase in productivity was 22 percent (32 percent of the gain over the first two years) in the logarithmic model and 12 percent of final levels of productivity (28 percent of the gain) in the linear model.

An alternative approach to estimating the impacts of training is to examine the productivity growth of particular new hires. Column 3 of Table 7 presents results using productivity data on a particular new hire rather than a typical new hire. Missing data reduces sample sizes by about 100. The variance of productivity growth across firms is larger when actual individuals are the data rather than typical individuals. R squares of the models are slightly higher, however, because characteristics of the worker and the worker's tenure at the time of the interview are included in the structural model of productivity growth. In order to minimize simultaneity problems, the training variables used in these models were for a typical new hire rather than for that particular new hire. Comparisons of the coefficients in column 3 and 2 reveal that substituting data on productivity growth outcomes of particular individuals for data on typical hires and controlling for personal characteristics does not change the estimated effects of training.

The impacts of each type of training are remarkably similar. This was not anticipated because some forms of training (e.g., formal training) have much higher hourly costs than others (e.g., watching others do the work), and this was expected to result in the more expensive forms of training having larger impacts on productivity than the cheaper forms. Measured in the units of productivity of a worker with 2 years of tenure on the job, the hourly cost of learning by watching others is .8. Formal training with a cost factor of 1.8 is the most expensive because it requires the time of both the trainee and the trainer. The cost of informal training by supervisors (a cost factor of 1.5) and by co-workers (cost factor of 1.0) lies between these two extremes because the trainee is engaged in production and only the time of the supervisor and co-worker must be charged off as a cost of training. If one accepts these estimates of the relative costs of different forms of training, the results imply that informal training by co-workers and training yourself by watching others have a higher rate of return than informal training by supervisors.[7]

Factors Influencing the Marginal Payoff to Training

Equation 11 implies that the impact of an additional hour of training on productivity growth, $P'(I_j)$, will be higher at companies with high required rates of return (r_j), high separation rates (s_j), high skill obsolescence rates (δ_j), high opportunity costs of training time (Θ_j), and low hours per week (H_j). Since workers reap benefits from training even when there is a separation, training investments should, in theory, be carried further (ie. to a point where marginal benefits are lower) when a job requires general skills rather than specific skills (ie. as $g \rightarrow 1$). This suggests that an hour of general training will typically have a smaller effect on productivity growth than an hour of specific training. On the other hand, training that is general must be financed by the worker not the firm. Since young entry level workers are generally liquidity constrained, the rates of return required by workers are likely to be considerably higher than the rates of return required by employers. This has the opposite implication. The inability of workers to finance general training may substantially depress such investment and marginal payoffs to such investment may be very high as a result. The relative importance of these two effects can be tested by interacting training intensity with a measure of the proportion of skills that are general (g).

Another job characteristic that is likely to influence the marginal product of an hour of training is the size of the establishment. Large establishments are likely to have higher opportunity costs of training time (Θ) and to be more efficient trainers (because of economies of scale). This suggests that marginal impacts of training may be higher at large establishments than small establishments. Formal training is considerably more common at large establishments and this suggests that the marginal impact of formal training may be particularly high at these establishments. To examine these issues, the models were respecified so as to allow for three-way interactions between training intensity, generality of training, size, and the share of training that was formal, watching others, and informal OJT by a co-worker. The specification used was the following:

(14) $P_{2YR}-P_{2WK} = \underline{BX} + b_1 lnL + b_2 lnT + b_3(lnT)^2 + b_4 E lnT + \underline{b_5 S} lnT + \underline{b_6 E S} lnT + b_7 g lnT + u$

where E = logarithm of (Establishment Employment/18.5)

$\underline{S}$ = a vector of shares of training that are formal, watching others, and informal OJT by co-workers. The excluded category is informal OJT by managers and supervisors.

g = the proportion of the skills learned useful at other firms.

Table 8

Impact of Training on Wage and Productivity Growth of a Particular New Hire

	Productivity Growth (Log)				Wage Growth (Log)				Productivity Growth (Linear)		Wage Growth (Linear)	
ln Training Weeks	.053***	(4.55)	.051***	(4.44)	.0073**	(2.19)	.0067*	(1.93)	.019***	(3.38)	.0046	(.90)
ln Training Intensity	.115***	(9.35)	.092***	(6.82)	.015***	(4.26)	.0089***	(2.92)	.041***	(5.46)	.0064	(.96)
ln Tr. Intensity x Size			.0099***	(4.11)			-.0001	(.12)	.0064***	(5.48)	.0007	(.68)
ln Tr. Intensity x Share General			.0043	(.45)			.0029	(1.08)	.0018	(.40)	.0073*	(1.76)
ln Tr. Intensity x Share Formal			.064***	(3.66)			.014***	(2.86)	.011	(1.24)	.022***	(2.86)
ln Tr. Intensity x Share Co-Worker			.025	(1.51)			-.001	(.23)	.011	(1.37)	-.004	(.52)
ln Tr. Intensity x Share Watch			.038***	(2.70)			.007*	(1.82)	.009	(1.34)	.017***	(2.71)
Tenure	.083***	(2.58)	.104***	(3.20)	.099***	(10.35)	.098***	(10.15)	.091***	(5.78)	.098***	(6.31)
Tenure Sq.	-.0078*	(1.73)	-.0094**	(2.11)	-.0024*	(1.76)	-.0023*	(1.71)	-.0088***	(4.07)	-.0045**	(2.15)
Standard Error of Estimate	.628		.622		.178		.178		.303		.269	
R Square	.164		.181		.233		.238		.162		.126	
Number of Observations	2002		2002		1963		1963		2002		1963	

* Significant at the 10% level (two-sided)
** Significant at the 5% level (two-sided)
*** Significant at the 1% level (two-sided)

The results of estimating various versions of equation 14 are reported in tables 8 and 9. Table 8 reports the results of models predicting the productivity growth of a particular new hire in which coefficients b_3 and $\underline{b}_6$ have been constrained to be zero. These models provide evidence on the effect of the generality of training and establishment size on the marginal product of training. The coefficient on the interaction between the generality of training and training intensity is positive but very close to zero. The two effects discussed above appear to have canceled each other out. It appears that the difficulties that workers face in financing general training are as severe a barrier to investment in general training as high separation rates are to investments in specific training.

The coefficient on size interacted with training is positive and highly significant in both the logarithmic (column 2) and linear (column 5) model of productivity growth. The logarithmic results imply that the elasticity of productivity with respect to training is 0.092 at establishments with 18.5 employees and about 0.1156 for companies with 200 employees.[8] The positive and significant coefficient on interactions between intensity of training and the share that is part of a formal training program or that is watching others do the work implies that these forms of training have significantly larger effects on productivity growth than OJT by supervisors, the excluded training category. Clearly, the earlier conclusion that marginal rates of return to watching others and to co-worker OJT are higher than marginal rates of return to supervisor OJT is pretty robust with respect to substantial changes in specification (alternative ways of defining the independent variable, alternative ways of specifying the training variables and the use of productivity growth of particular new hires rather than a typical new hire as the dependent variable). Findings regarding the payoff to formal training, on the other hand, appear to depend upon specification.

Table 9 presents the results of testing the hypothesis that the size of the establishment differentially effects the rate of return to specific types of training. The models presented in this table included interactions of size with (share times log total training). While the coefficients on these interactions are not significant in the particular worker models, interactions between formal training and size are significant in the typical worker specifications. As hypothesized, the payoff to formal training increases more rapidly with establishment size than the payoffs to other forms of training. These results help explain why formal training programs are more common at large companies than at small companies. In the linear typical worker specification, watching others do the work seems to be a less effective learning technique at large companies than at smaller companies. The coefficients on this variable in other specifications are negative but not significantly different from zero.

Table 9
Impact of Training on Wage and Productivity Growth

	Log Productivity				Productivity Growth Linear				Log Wage Growth			
	Typical Worker (2 Yrs.)		Particular Individual (1.2 Years)		Typical Worker (2 Yrs.)		Particular Individual (1.2 Years)		Typical Worker (2 Yrs.)		Particular Individual (1.1 Years)	
Ln Length of Training	.060***	(5.59)	.047***	(3.99)	.027***	(5.16)	.019***	(3.40)	.007**	(2.05)	.0065*	(1.92)
Ln Training Intensity	-.140***	(2.59)	-.097*	(1.66)	.003	(.13)	.038	(1.33)	.022	(1.24)	.0056	(.33)
(*Ln* Training Intensity) sq.	.0313***	(4.72)	.0236***	(3.28)	.0064*	(1.96)	.0004	(.13)	-.0025	(.76)	.0007	(.34)
<u>Interaction of Log Training Intensity with</u>												
Share OJT Formal	.028*	(1.72)	.051***	(2.82)	.003	(.33)	.009	(1.00)	.018***	(3.27)	.013**	(2.54)
Share OJT by Co-worker	.020	(1.24)	.023	(1.36)	.010	(1.30)	.010	(1.24)	.003	(.66)	.0000	(.01)
Share OJT by Watching Others	.044***	(3.34)	.040***	(2.81)	.013**	(1.99)	.009	(1.28)	.007*	(1.17)	.0075*	(1.84)
Size=*ln*(Estab. Employment/18.5)	.005	(1.21)	.0066	(1.41)	.005**	(2.53)	.0058*	(2.52)	.0036**	(2.54)	.0003	(.24)
Size*(Share OJT Formal)	.024**	(2.33)	.012	(1.11)	.0083*	(1.67)	.0068	(1.28)	-.0025	(.76)	.0025	(.79)
Size*(Share OJT by Co-worker)	.016	(1.54)	.014	(1.19)	.0067	(1.32)	.0043	(.78)	-.0116***	(3.44)	-.0031	(.93)
Size*(Share OJT Watching Others)	-.009	(.93)	-.000	(.01)	-.0106**	(2.27)	-.003	(.63)	-.0045	(1.46)	-.0004	(.15)
Standard error of estimate	.591		.621		.291		.303		.185		.178	
R^2	.189		.186		.156		.165		.211		.238	
Number of Observations	2116		2002		2116		2002		1986		1963	

* Significant at the 10% level (two-sided)
** Significant at the 5% level (two-sided)
*** Significant at the 1% level (two-sided)

Past efforts to assess rates of return to OJT have focused on the wage payoff to worker investments in training (Mincer 1989). This effort is fraught with difficulties, however, because it is very difficult (a) to measure what employees [as opposed to employers] invest in training and (b) to distinguish wage increases caused by training from wage increases caused by selective turnover or the need to discourage shirking by back-loading compensation packages.[9] The total returns to employer and employee investments (both general and firm specific) have not been evaluated because data on productivity effects was lacking. This study has generated tentative estimates of both the opportunity costs and the productivity effects of training (general and specific, worker and firm financed combined). It would appear, therefore, feasible to calculate marginal gross rates of return (for general and specific training combined) necessary to cover the cost of capital, losses due to turnover and obsolescence. The data was not collected for this purpose, however, so there are gaps that can only be filled by some judicious assumptions. Consequently, the estimates of marginal gross rates of return for each form of training that are reported in table 11 must be viewed as very tentative results which will hopefully be displaced shortly when better data sets become available. Because the period for which training intensity is measured is much shorter than the period over which productivity growth is measured, an assumption must be made about the strength of the correlation between training intensity during the first 3 months and training hours during the rest of the 2-year period. When the two year productivity gain of the typical new hire is being analyzed, a unit increase in a training activity during the first 3 months was assumed to be associated with a further 2-unit increase in that training activity during the rest of the 2-year period.[10] When the productivity gain during the first fourteen months for a particular new hire is being analyzed, a unit increase in a training activity during the first 3 months was assumed to be associated with a further 1.2 unit increase in that training activity during the remainder of the first year on the job. Marginal GRORs are the ratio of the increment to yearly productivity generated by a small increase training divided by the cost of increased training (A detailed description is in the notes of Table 10).

The estimated marginal rates of return diminish as the intensity of training increases. The mean training intensity for the first 3 months expressed in units of the time of trained workers is 148 hours. As intensity during the first 3 months rises from 100 hours to 300 hours (double the mean), the marginal rate of return (ROR) for informal OJT by co-workers drops from 43-45 percent to 25-32 percent in the two linear models for typical new hires presented in table 8. The linear model's ROR drops from 38-43 percent to 25 percent for watching others and from 17-23 percent to -1 to 10 percent percent for training by supervisors. The ROR of formal OJT is estimated to

Table 10
Sensitivity of Marginal Gross Rates of Return Estimates to Specification

	Formal Training		Training by Supervisors		Training by Co-Workers		Watching Others	
	100 hrs	**300 hrs**	**100 hrs**	**300 hrs**	**100 hrs**	**300 hrs**	**100 hrs**	**300 hrs**
Table 8								
Typical Individual								
Linear	11%	- 3%	23%	10%	45%	32%	38%	25%
Logarithmic	38%	15%	46%	24%	85%	63%	113%	90%
Particular Individual								
Linear	15%	- 3%	17%	- 1%	43%	25%	43%	25%
Table 9								
Typical Individual								
Logarithmic	118%	54%	99%	48%	112%	53%	128%	58%
Linear	43%	16%	41%	16%	48%	18%	50%	18%
Particular Individual								
Logarithmic	156%	68%	109%	52%	130%	59%	146%	64%
Linear	46%	16%	38%	13%	47%	16%	46%	16%

Estimates of the marginal gross rates of return to increases in the intensity of training at two different levels of training intensity: a 100 hour investment during the first quarter of the job and a 300 hour investment during the first quarter on the job. Hourly cost factors are assumed to be 1.8 for formal training, 1.5 for training by supervisors, 1.0 for training by coworkers, and 0.8 for watching others. When productivity growth over 2 years for the typical individual is being modeled, duration adjusted cost factor is calculated by multiplying by the hourly cost factor by 3 for the reasons given in the text. When productivity growth of a particular individual during the first 14 months is modeled, the duration adjusted cost factor is calculated by multiplying the hourly cost factor by 2.2. The results presented in the first panel are calculated by taking the derivative of the estimated regression equations reported in tables 4 with respect to hours of the specified kind of training, then multiplying by 2000, the assumed number of hours worked in a year, and then dividing by the duration adjusted cost factor. As an example of the calculation, the formula for formal OJT using the coefficients from the linear model in table 4 for training intensity (T) equal to 300 hours was as follows:
[(.00046 - .00000049*T*2*1.8)*2000] / [3*1.8] = -.0256 and the coworker training formula is:
[(.00077 - .00000049*T*2)*2000]/[3] = .3173. {Note that the coefficients must be divided by 100 and 10000 in order to scale them in hours of training}. The GROR estimates presented in the second panel assume that the firm has 18.5 employees (this zeros out the 5th and 7th terms of equation 3) and that all of the training received is of the type indicated. For informal training by supervisors, the formula is:
$(b_2 + b_3 * ln T*2)*2000/(T*\text{duration factor})$ which is [(.003 +.0064*4.605*2)*2000] / (100*3) =.4176 at T=100 for the linear productivity growth model for typical workers. For training by watching others, the formula is $(b_2 + b_{5W} + b_3 * ln T*2)*2000/(T*\text{duration factor})$ which is $[(.003 + .013*S_W +.0064*4.605*2)*2000] / (100*3)$ =.504. Obsolescence of skills and turnover mean that these cash flows do not have an infinite duration and should therefore be compared to the sum of the interest rate, the obsolescence rate and the turnover rate times the proportion of skills that are effectively specific to the firm.

drop from 11-15 percent at 100 hours to -3 percent at 300 hours. Estimated rates of return for particular workers are generally slightly higher than those calculated for the typical worker. Estimated rates of return calculated from models based on logarithmic specifications are considerably higher than those based on linear specifications of productivity growth. At the training intensities that typically prevail during the first quarter, marginal rates of return seem to be rather high. Since the impacts of training intensity were calculated while holding the length of training fixed, these GRORs should be viewed as placing lower bounds on the true relationship.

It must be remembered, however, that these marginal GRORs include cash flows necessary to compensate for turnover and obsolescence and are, therefore, not directly comparable to the real rates of return to schooling and financial assets that typically lie in the range from 5 to 10 percent. If all training investments are specific to the firm and must, therefore, be written off if workers leave and turnover is high, GRORs of 30 percent or more may be required to induce the firm to invest in specific training. Lillard and Tan (1986) have estimated that training depreciates at 15 to 20 percent per year. This also would imply that equilibrium in the training market would likely yield marginal GRORs of 30 percent or more. With all the uncertainties regarding the best specification of the productivity growth model, measurement error in the training variables, the specificity of the training, turnover rates, and the obsolescence rates, it is my view that robust estimates of net rates of return to on-the-job training are not now feasible and will not be feasible until better data sets become available.

Results Using Instrumental Variables

The discussion so far has assumed that the causation runs from training to productivity growth. It might be argued that when one is examining relationships for a typical worker that firms hiring workers with very low initial productivity will find it profitable to provide more than average amounts of training. Consequently, when initial productivity is not controlled, there may be simultaneity bias in our models. A second econometric problem that is likely to be effecting the results is errors in measuring training. Measurement error is probably biasing down our estimates of the effect of training on productivity growth. To test for these biases, we estimated the model of productivity growth using instrumented values of training rather than the actual training investments.

The X variables used in estimating the models predicting investment in training in Table 6 were divided into two parts: those that theory predicts directly influence productivity growth and those which influence the cost of training without directly affecting rates of productivity growth

Table 11

Comparison of OLS & Instrumental Variable Estimates of the Impact of Training

Productivity Growth (Linear)		Training Intensity (100's hrs.)	Training Intensity Squared (10,000's)	Log Weeks of Training	R^2
Typical Hire	OLS	.112***	-.012***	.026***	.142
		(9.3)	(6.5)	(4.9)	
	2SLS	.333***	-.034*	-.058*	.076
		(3.1)	(1.8)	(1.7)	
Particular New Hire (1.2 Years)	OLS	.107***	-.014***	.017***	.152
		(8.)	(6.8)	(3.2)	
	2SLS	.423***	-.058***	-.064*	.115
		(3.6)	(2.8)	(1.7)	
Wage Growth (Linear)					
Typical Hire	OLS	.028***	-.0023*	.0082**	.197
		(3.5)	(1.8)	(2.3)	
	2SLS	.147*	-.025*	.010	.181
		(1.9)	(1.9)	(4)	
Particular New Hire (1.2 Years)	OLS	.022***	-.0019	.0072**	.232
		(2.8)	(1.6)	(2.1)	
	2SLS	-.009	-.0039	.048**	.223
		(.1)		(2.1)	

* Significant at the 10% level (two-sided)
** Significant at the 5% level (two-sided)
*** Significant at the 1% level (two-sided)

conditional on training. The variables in this latter category were the number of alternative employers, dummies for industry, the growth rate of employment, the growth rate of sales, the number of employees at the establishment, the size of firm, the wage rate, a dummy for wage at or below the minimum wage, a dummy for temporary job, dummies for no probationary period, the log of length of the probationary period, dummies for not knowing if there is a probationary period, a measure of the difficulty of firing a worker after the probationary period is ended, a measure of the importance of seniority in determining who is laid off, and characteristics of the local labor market. These variables were used as instruments for the training variables. This involves maintaining the hypothesis that these variables influence the cost of training investments, and therefore, the level and composition of training without influencing the rate at which new employees learn. The X variables assumed to have direct impacts on productivity growth were dummies for occupation, the specific vocational preparation (SVP), and the general educational development (GED) that the Dictionary of Occupational Titles (DOT) specified is necessary for the job, percent of work force skilled, percent of work force who are crafts workers, the importance of vocational education in selection, cost of machinery, unionization, hours worked per week, and characteristics of the hires (i.e., percent under age 25), and an employer response that it is hard to find reliable unskilled workers. When outcomes for particular individuals were being modeled, the new hires' education, sex, and work experience were included in the structural model.

The results from a variety of specifications are reported in Table 11. In most cases, estimating by intrumental variables (IV) rather than OLS has the effect of increasing the magnitude of coefficients but reducing their statistical significance. The IV results also reverse the sign of the coefficient on length of training. The fact that the IV estimations increase rather than reduces the estimated effects of training intensity suggests that measurement error biases are more serious than simultaneity bias and lends support to our general conclusion that marginal rates of return to employer-provided training are very high.

V. Impact of Training on Wage Growth

The costs and benefits of investments in on-the-job training are shared by employer and employee. This implies that jobs with a great deal of training will tend to have lower starting wage rates than would otherwise be predicted and higher wage rates once the training is completed. In other words, jobs with a heavy training component--either because it requires great skill or because the people being hired for it are completely inexperienced--will have higher rates of wage growth than other jobs. The more general the training the greater will be the share of training costs that is paid by the new employee and the greater will be the resulting rate of wage growth. Since some types of training are more effective than others, some are more general than others and some are more visible to other employers than others, one would expect different types of training to have different effects on wage growth. Are the impacts of different types of training on wage growth similar in pattern to their impacts on productivity growth? Or, is the pattern of wage growth responses to different types of training more influenced by the generality and visibility of the specific type of training?

These issues were addressed by estimating wage growth counterparts to the productivity growth models presented in Tables 7, 8 and 9. The first dependent variable studied was the log of the ratio of the firm's current wage for a worker with 2 years of tenure to the actual starting wage of a person who had recently been hired for the position. Models predicting this variable control for the effects of wage inflation by including the date of hire and it's square in the specification. The results are presented in column 4 of Table 7 and column 5 of Table 9.

The second dependent variable is the log of the ratio of the current wage rate (or most recent wage if there has been a separation) and the starting wage rate for a particular new employee who was hired on average 14 months earlier. The models predicting this variable are presented in column 5 of table 8, column 3 and 4 of Table 8 and column 6 of Table 9. The third dependent variable is the difference in dollars and cents between the current (or most recent) wage rate and the starting wage rate of a particular new hire. These models control tenure of the worker on the date for which wages are reported. The results of predicting this measure of wage growth are reported in column 6 of Table 8. All three models contain controls for the characteristics of the new hire, the occupation, SVP, and GED of the job, percent of craft workers and percent of skilled workers at the firm, the cost of machinery used in the job, unionization, importance of vocational training in selection, percentage of the firm's work force under age 25, and reported difficulty in finding reliable unskilled workers.

The first conclusion that can be drawn from an examination of the wage growth results is that training does have the hypothesized positive effect on wage growth. The effect is statistically significant in almost all of the models. Comparisons of these coefficients with the estimates of the impact of training on productivity growth, however, reveal that training has a much smaller impact on wage growth than it has on productivity growth. In table 8, an increase in informal training from 0 to 100 hours raises productivity of typical employees by 13 to 15 percent in the logarithmic model and 5.3 to 7.7 percent in the linear model, but raises wage rates by only .1 to 2.0 percent.

A doubling of the length of training raises productivity by 2.2 to 4.8 percent, but wage rates rise only 0.7 percent.[11]

In Table 8's logarithmic models for a particular individual, doubling the length of training increases productivity growth by 3.6 percent and increases wage growth by only .5 percent. Doubling the intensity of training, increases productivity growth by 8 percent but raises wage growth by only 1.1 percent. Productivity growth effects of training are also considerably greater than the wage growth effects in the linear models reported in column 5 and 6.

For findings such as these, the first explanation that comes to mind is that the training is specific and the firm is paying most of its costs and reaping most of its benefits. Since skills are thought to be more specific at large companies, the fact that the gap between the productivity and wage effects of training is largest at big establishments provides further support for the skill specificity explanation. The problem with this explanation, however, is that when employers were asked whether the skills learned on their jobs were specific to the firm, most reported to the contrary that the skills were useful at other firms. Furthermore, the generality of skills taught has only very modest effects on the magnitude of the wage response to training. When training is done by managers and the skills are reported to be entirely general, doubling training intensity raises productivity by 6.7 percent but wages by only .8 percent in the logarithmic model reported in columns 2 and 4 of Table 8. In the linear model in column 5 and 6 of Table 8, doubling training raises productivity by 3 percent while increasing wage growth by only .96 percent. Analysis of data on the typical new hire produces very similar findings. These results appear to contradict an important prediction of Becker's theory--when training is general, its impact on wage growth should equal or exceed its impact on productivity growth. Even though employers claim the skills they are teaching are general, the labor market is not treating these skills as if they were general. How can these puzzling results be explained?

One explanation of the phenomenon is that different firms require different mixes of general skills. The firm that does the training concentrates on those skills it needs the most, some of which may not be as highly valued by alternative employers. Skills that would be highly valued by an alternative employer may not be taught because others on the staff already fulfill that function. As a result, the package of general skills that workers develop are always more valuable at the training firm than at other firms even when each individual skill is correctly perceived to be useful elsewhere.

A second reason why the market behaves as if general skills are effectively specific to the firm is that other employers will generally be ignorant of the exact character of a new hire's general skills and, consequently, will often not assign the worker to a job that puts the skills to work. Even when a worker's next job makes use of the general skills learned, there is no guarantee that new hires with better than average skills will be offered comparably higher entry wages. These phenomena have the effect of transforming some skills which are technically general into skills which are effectively specific to the firm. To the extent training is effectively specific, wages will rise more slowly than productivity net of training cost (Bishop and Kang 1984, 1988).

Support for this signaling/visibility explanation of the gap between productivity and wage rate effects of training comes from comparing the gaps for specific types of training. In table 8, all forms of training had roughly equal effects on productivity growth. For wage growth, however, formal training has much larger effects than other forms of training and OJT by co-workers has no effect. Apparently, formal training is less specific to the job and more visible to the employee and other employers, and thus workers are more willing to contribute to its costs. The importance of OJT provided by co-workers is apparently underestimated by all concerned, the employee, the supervisor, and other employers.

The third reason why general training masquerades as specific training is the inability/unwillingness of most young workers (the ones who have the greatest need for general training) to finance large amounts of general on-the-job training. Most of these workers are liquidity constrained--that is they are unable to shift as much consumption from the future into the present as they would like because they have neither assets which can be depleted nor access to credit at reasonable terms.[12] Half of households headed by someone under the age of 25 have less than $746 in financial assets and 19 percent have no financial assets at all. Half of households headed by someone between 25 and 34 have less than $1514 in financial assets and 13 percent have none (Survey of Consumer Finances 1984). Subsidized or guaranteed student loans are not available to finance on-the-job training and banks will not lend money for this purpose without collateral. Borrowing against the equity in one's home is a possibility for some but only 34 percent of households with heads under the age of 35 own a home and many of the houses have been owned for only a short while, so the equity that can be borrowed against is small. Even with collateral, the loans available to individuals usually carry higher interest rates than those charged businesses. Studies of the willingness of consumers to substitute consumption over time have all concluded that the intertemporal elasticity of substitution is no higher than one and most studies conclude it is .5 or below (Friend and Blume 1975; Hall 1988; Hubbard and Judd 1986). A substitution elasticity of .5 implies that reducing a liquidity constrained worker's wage by one half (in order to pay for general training) roughly quadruples the worker's marginal utility of consumption. Such a worker would be willing to give up four dollars of future income in return for one dollar of current income. The liquidity constraint phenomenon has little effect on the wage profile of jobs requiring no general training and which, therefore, have a flat productivity profile. Where significant general training is occurring, however, it comes into play and may result in an employment contract in which the employer shares the costs of general training (Glick and Feuer 1984; Feuer, Glick and Desai 1987).

VI. Impact of Training on Turnover

One would expect more productive workers to be more likely to be promoted and less likely to be separated involuntarily. Consequently, the amount and nature of training that is typical at a firm should influence turnover. To test this hypothesis, models were estimated predicting the actual tenure, probability of a dismissal, probability of a quit and probability of a promotion of particular new hires. Controls were included for the log of potential tenure and its square, background characteristics of the individual worker, and characteristics of the job, the firm and the local labor market.

The training variables were specified so as to allow a test of three hypotheses. The first hypothesis was that a policy of providing greater amounts of training lowers turnover and increases the propensity to promote new hires. The second hypotheses was that this effect would be strongest at the larger firms where training has larger effects on productivity. The third hypotheses is that because formal training is more visible to the firm providing the training, the employee, and other employers, it tends to raise the quit rate, reduce the dismissal rate, and raise the promotion rate more than other forms of training.

The results are presented in Table 12. Establishment size was scaled as a ratio to its geometric mean of 18.5 before being logged and interacted with training intensity. Consequently, the coefficient on training intensity estimates the magnitude of the training intensity's impact on turnover for establishments with about 19 workers. Surprisingly, there is no statistically significant effects of either the length or intensity of training on expected tenure or rates of dismissal or quitting at the small establishments that predominate in the sample. There is a statistically significant interaction between establishment size and training intensity, however. At larger companies, a higher training intensity for typical workers is associated with longer tenure. At small companies, the reverse association exists. Effects are very small, however. A doubling of training investment raises expected tenure by only 1.3 percent at a company with 200 employees and lowers expected tenure by only 1.7 percent at a company with 2 employees. In these results, we have still

Table 12

IMPACT OF TRAINING ON TURNOVER AND PROMOTIONS

Training	Log Tenure	Involuntary Separation	Quit	Promotion
Log Length of Training	.011	.004	-.007	.004
	(1.1)	(.6)	(1.0)	(.4)
Log Intensity of Training	-.002	.004	-.006	.040***
	(.1)	(.6)	(.7)	(3.8)
Interaction of Training Intensity With:				
Establishment size	.009*	-.004	-.005	.010**
	(1.8)	(1.3)	(1.2)	(2.1)
Share formal training	.014	-.011	.017*	-.001
	(1.1)	(1.3)	(1.8)	(.1)
Share OJT by co-worker	.004	-.006	.004	-.015
	(.3)	(.8)	(.4)	(1.2)
Share watching others	-.007	.009	-.005	-.010
	(.6)	(1.3)	(.6)	(.9)
R Squared	.658	.050	.049	.108

* Significant at the 10% level (two-sided)
** Significant at the 5% level (two-sided)
*** Significant at the 1% level (two-sided)

another reason why large companies typically make greater investments in training than small companies.

The hypotheses that formal training would have larger effects on turnover than other forms of training is supported by the data. For quit rates, there is a statistically significant difference between the impact of formal and informal types of training. Point estimates imply that informal training reduces the quit rate and that formal training increases the quit rate. This lends support to our hypotheses that formal training is both more useful at other firms and more visible to other employers and that informal training is either in skills specific to the firm or invisible to other employers.

The training provided to typical new hires has a much more significant impact on promotions than it has on turnover. At a company with 19 employees doubling the amount of training raises promotion propensities by 3 percentage points. There is a significant interaction with establishment size. If the establishment has 200 employees, doubling training intensity raises promotion propensities by 4.6 percentage points.

VII. Implications of Empirical Findings for the Hypothesis that Americans Under-Invest in On-The-Job Training

The major findings derived from the analysis of the data on new hire training may be summarized as follows:

* Training investments in new hires are substantial even for jobs that are generally considered unskilled.

* Formal training provided by specialized training personnel accounts for only a small portion of the training received by new hires.

* Productivity rises substantially during the first year on the job.

* To fill jobs requiring a great deal of on-the-job training, employers prefer applicants who have previous relevant work experience, who are well educated and who have vocational training in a relevant field.

* Large establishments invest more in the training of their new hires than small and medium sized establishments because (1) they have lower turnover, (2) they have better access to capital markets, (3) the marginal product of an hour of training time is higher at large establishments and (4) training lowers turnover more substantially at large establishments.
* The elasticity of demand for training is below unity.

* When it is a binding constraint, the minimum wage lowers training investment by roughly 17 percent during the first 3 months on the job and productivity growth by 5 to 10 percent.

* Informal training by coworkers and training by watching others do the job appear to have a higher benefit cost ratio than informal training by management.

* Estimates of rates of return to training derived from this data should be treated with a great deal of caution. Nevertheless, **marginal rates of return to training appear to be quite high.**

* The estimated benefit cost ratio for formal training depends on how the model is specified. The productivity growth effects of formal training are bigger at large establishments. Formal training has significantly larger effects on wage growth than informal training. Formal rather than informal training significantly increases the worker's propensity to quit. **Formal training's tendency to have larger effects on wage growth and quit rates than informal training probably results from the fact that formal training is better signaled to the labor market.**

* The reported generality of training has no significant effects on its marginal productivity or on the effects of training on turnover.

* When training is reported to be highly general, training has a larger effect on wage growth than when training is reported to be specific. Nevertheless, **training that is reported to be entirely general has much larger effects on productivity growth than wage growth implying that the labor market treats this training as if it were at least partly specific to the firm.**

These results provide support for the view that workers do not pay the full costs of general training and do not receive wage increases equal to the full productivity effects of general training. They also lend support to our hypothesis that the outcomes of training, particularly informal training, are poorly signaled to the labor market. Because other employers are unaware of its exact character and unable to assess its quality prior to making hiring decisions, training that is technically general often becomes effectively specific to the firm and employers choose to share the costs and benefits of investments in general training [see Bishop and Kang (1984, 1988) for a formal proof of this statement]. The second hypothesized reason why shared financing of general training may be in the joint interest of employees and employers is the fact that young workers are typically liquidity constrained while employers are not.

If these conclusions are true, turnover becomes a more important determinant of training investments than previously thought. In the standard model, turnover propensities influence the amount of specific training supplied but not the amount of general training undertaken. However, if employers finance some of the costs of general training (or general and specific training are joint products of the same training activity), worker's with high turnover propensities are likely to find it hard to obtain jobs that offer general as well as specific training. For those with less than one year of tenure, the probability of staying at the firm for at least 12 additional months is over 80 percent in the United Kingdom, 76 percent in Japan but only 41 percent in the US (OECD, 1984, Table 33 and 34). The high rates of turnover in America, then, help explain why investments in both specific and general on-the-job training of new hires are lower in this country than in Japan and Germany.

One important reason why turnover is so high in the US youth labor market is job shopping and tryout hiring. When the match is first arranged, both the employer and the job seeker are poorly informed about each other, so they spend the first months learning about each other and, if they do not like what they discover, they terminate the relationship. If they knew more about each other going into the match, there would be fewer surprises, fewer quits and fewer dismissals. There are good reasons why try out hiring is so prevalent in the US. There are major institutional barriers to the free flow of information about job applicants--such as EEO testing guidelines, the failure of high schools to send out transcripts and the threat of law suits if bad recommendations are given--that do not exist in other countries. German and Japanese employers are much more careful in their selection of blue collar and clerical employees than American employers (Rosenbaum and Kariya 1987; Koenig 1987).

A second reason why turnover is higher in the US is that there are fewer legal and contractual obstacles to layoffs in the US (Sengenberger 1985; Flanagan 1986).[13] Thirdly, turnover appears to be less costly for young American workers than for young German and young Japanese workers. It has already been noted that specific training is more extensive in Japan, and the loss of these investments is a disincentive to turnover. Transition costs also discourage turnover (Bishop and Kang 1988) and there is reason to believe that there may be differences across countries in the magnitude of these transition costs . In some countries, quitting or being laid off does serious damage to the worker's reputation and the likelihood of finding another good job. The best Japanese employers hire straight out of high school and are said to discriminate against those with work experience. The reverse prevails in the US. Quitting appears to be much less stigmatizing in the US than in Japan particularly for young workers.

In Germany, the apprenticeships have a three month probationary period during which either party may opt out of the contract without serious consequences. Nevertheless, only 5 percent of apprentices change employers during this period. An apprentice who quits his apprenticeship after the probationary period will find it very difficult to get another one. As a result, about 95 percent of those who finish the first 3 months of their apprenticeship stick with it for the full three years and pass the performance exam that comes at the end. While, apprentices are not subject to layoff when there is slack work, journeymen are. Who is laid off is often based on job performance not seniority, so being laid off is more stigmatizing than it is in the US. To protect themselves from this stigma, German workers bargain for employment contracts which reduce the probability of layoffs by front loading compensation and mandating severance pay.

The result is lower turnover, a higher payoff to employer investments in specific and general training, greater training investment and, as a result, strong productivity growth. Mincer and Higuchi (1988) correctly point out that causation also runs in the opposite direction--high rates of investment and technological progress increase the returns to training and raise the disincentives for turnover.

An examination of equations 11 and 12 suggest a number of additional reasons for the relatively low level of on-the-job training investment in the United States. The most obvious explanation of the heavier investment in training by Japanese corporations is the very low costs of capital they face. The fact that Japanese companies operating in the US spend more on training than American companies in the same industry provides further support for this hypothesis (Mincer and Higuchi 1988). A second possible explanation is that Japanese and German workers are better educated and consequently faster learners (ie. $P'(I)$ is higher in Japan). A third explanation is the minimum wage which prevents unskilled American workers from offering to pay for general training by accepting a sub-minimum wage during the training period.

A fourth reason for the contrast is the lack of a strong apprenticeship system in the US. The standardized curriculums and the proficiency exam at the end of the apprenticeship mean that the quality and nature of the training is well signaled to employers in Germany, Switzerland and Austria. The result is that the worker can count on benefiting from doing a good job in their apprenticeship even if the training employer does not keep them on. Since the future payoff is certain, German apprentices are willing to start out at a wage that is only about one-quarter of the wage they will be able to command at the end of the apprenticeship. If the apprentices were adults, they could not afford to accept so low a wage. They are, however, teenagers who because they live at home are heavily subsidized by their parents. Consequently, the liquidity constraint that is such a barrier to heavy investments in general training in the US is much less of a problem in Germany.

BIBLIOGRAPHY

Becker, Gary. "Investment in Human Capital: A Theoretical Analysis." Journal of Political Economy, Vol. 70, No. 5 pt.2, October 1962, 9-50.

Bishop, John. "Job Performance, Turnover and Wage Growth." Journal of Labor Economics, Vol. 8, No. 3, September 1990, pp. 363-386.

Bishop, John and Kang, Suk. "On-the-Job Training/ Sorting: Theory and Evidence" National Center for Research in Vocational Education, Ohio State University, 1984.

Bishop, John and Kang, Suk. "A Signaling/Bonding Model of Employer Finance of General Training." Center for Advanced Human Resource Studies, Cornell University, Ithaca, New York, 1988.

Bishop, John; Hollenbeck, Kevin; Kang, Suk and Willke, Richard. Training and Human Capital Formation. Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1985.

Feuer, M., Glick, H., and Desai, A. "Is Firm-Sponsored Education Viable?" Journal of Economic Behavior and Organization, March 1987, Vol. 8, No. 1.

Flanagan, Robert. "Labor Market Behavior and European Economic Growth." paper prepared for conference on Impediments to European Economic Growth, The Brookings Institution, 1986

Friend, Irwin and Blume, Marshal. "The Demand for Risky Assets." American Economic Review, Vol 65, December 1975, pp. 900-922.

Garen, John. "Empirical Studies of the Job Matching Hypothesis," in Ron Ehrenberg ed., Research in Labor Economics, Vol. 9, Greenwich, Conn.: JAI Press, 1988.

Glick, Henry A. and Feuer, Michael J. "Employer-Sponsored Training and the Governance of Specific Human Capital Investments." Quarterly Review of Economics and Business, Vol. 24, No. 2, Summer 1984.

Hall, Robert. "Intertemporal Substitution in Consumption." Journal of Political Economy, Vol. 96, No. 2, April 1988, pp. 339-357.

Hashimoto, M. "Firm-Specific Human Capital as a Shared-Investment." American Economic Review, 71, no. 3, March 1981, pp. 475-482.

Hashimoto, M. "Minimum Wage Effects on Training on the Job." American Economic Review, Vol 72, No. 5, December 1982, pp. 1070-1087.

Hollenbeck, K., and Smith B. The Influence of Applicants' Education and Skills on Employability Assessments by Employers. Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1984.

Hollenbeck, Kevin and Wilkie, Richard. "The Nature and Impact of Training: Evidence From The Current Population Survey." In Training and Human Capital Formation, edited by John Bishop et al., The National Center for Research in Vocational Education, The Ohio State University, July 1985.

Hubbard, R. Glenn and Judd, Kenneth L. "Liquidity Constraints, Fiscal Policy and Consumption." Brookings Papers on Economic Activity, 1986, # 1, pp. 1-60.

Hunter, John E.; Schmidt, Frank L. and Judiesch, Michael K. Individual Differences in Output as a Function of Job Complexity, Michigan State University and Department of Industrial Relations and Human Resources University of Iowa, June, 1988.

Jaikumar, Ramchandran. "Postindustrial Manufacturing." Harvard Business Review, November-December, 1986, pp. 69-76.

Koenig, Richard. "Toyota takes Pains and Time, Filling Jobs at its Kentucky Plant." Wall Street Journal, December 1 1987, p. 1.

Koike, Kazuo. "Skill Formation Systems in the U.S. and Japan: A Comparative Study." The Economic Analysis of the Japanese Firm, edited by M. Aoki, New York: Elsevier Science Publishers B. V., 1984, pp. 47-75.

Kosai, Yutaka. "Japan's Economic System--Will It Change?" seminar presentation, Department of East Asian Studies, Cornell University, April 26, 1989.

Krafcik, John F. Training and the Automobile Industry: International Comparisons. Contractor Report prepared for the Office of Technology Assessment under contract N3-1910, Feb. 1990.

Leighton, Linda and Mincer, Jacob. "Effects of Minimum Wages on Human Capital Formation." in The Economics of Legal Minimum Wages, edited by Simon Rottenberg, Washington DC: American Enterprise Insitiute, 1981.

Limbrecht, Joseph H. and Hayes, Robert H. "Germany's World- Class Manufacturers." Harvard Business Review, November-December, 1982, pp. 137-145.

Mincer, Jacob and Higuchi, Yoshio. "Wage Structures and Labor Turnover in the U.S. and Japan." The Journal of the International and Japanese Economy, Kyoto and Stanford, 1988.

Noll I., Beicht U., Boll G., Malcher W. and Wiederhold-Fritz S. Nettakosten der Betrieblichen Ber Ufsbildung Schriften Berufsbildungsforschung, Band 63. Beuth Verlag GMBH, Berlin, 1984.

Organization of Economic Cooperation and Development. Employment Outlook. Paris: OECD, September, 1984, Chapter 4.

Parsons, Donald. "Wage Determination in the Post Training Period." Pathways to the Future, Vol. 7, Chapter 7, Center for Human Resource Research, Ohio State University, 1985.

Salop, Joanne and Salop, Steven. "Self Selection and Turnover in the Labor Market." Quarterly Journal of Economics, Vol. 91, November 1976, p. 619-627.

Sengenberger, Werner. "Job Security--Germany." unpublished paper, OECD, 1985.

"Survey of Consumer Finances, 1983." Federal Reserve Bulletin. Vol 70, September 1984, p. 686 and December 1984, p. 863.

Weiderhold-Fritz, Susanne. "Is There a Relationship between Cost of In Company Vocational Training and the Offer of Training Places in the Federal Republic of Germany." Social Forces: Supplement on Youth Pay and Employers' Recruitment Practices for Young People in the Community, Commission of the European Communities, Directorate-Generale for Employment, Social Affairs and Education, 1985.

ENDNOTES

1. The use of the ratio to estimate the relative productivity implicitly involves an assumption that the productivity reports received from employers are a proportional transformation of true productivity plus a random error. The unknown factor of proportionality can be different for every job, every firm and every respondent but a single respondent is assumed to use the same proportionality factor when answering our questions. If alternatively it were assumed that these reports exaggerate the rate of growth of productivity with tenure by a factor of 2, estimates of training investment would be 7 to 15 percent lower. Comparisons across occupations or of new hires with different qualifications would not change appreciably.

2. When many workers can be trained simultaneously, the fixed costs of developing the training package and hiring a trainer are spread over a larger number of trainees. This means that the average hourly cost of formal training is generally smaller at large companies than small companies. For the small companies included in this study was assumed that the cost factor for formal training was roughly 1.8 times the value of an experienced coworker's time. For establishments with more than 200 employees, cost factors for formal training would be much lower, possibly between 1.2 and 1.4.

3. The index was constructed under an assumption that the four training activities were mutually exclusive. This implies that if the sum of the hours devoted to individual activities is greater than 520, that a reporting error has occurred which overstates investment in training. In the few cases where the sum of hours devoted to training exceeded 520, the training time index was adjusted downward by the ratio of 520 to the sum of the hours reported for individual activities. This procedure reduces the mean of the index by about 10 percent. The cost of the trainer and amortization of training package development costs was assumed to be two-thirds of the foregone productivity of a supervisor, since formal training often spreads fixed costs over more than one trainee. Thus $1.8 = (2/3)1.5 + .8$.

4. If the arithmetic mean were being reported these numbers would be considerably larger. Nevertheless these numbers seem low especially for professional and managerial jobs.

5. Many of the new hires who were paid less than \$3.35/hr were hired before the increase in the minimum to \$3.35/hr.

6. Because a number of employers reported that productivity was zero during the first 2 weeks on the job, 5 was added to all productivity index values before the productivity growth ratio was calculated.

7. Measurement error may bias these coefficients in a way that makes these findings stronger. Our respondent (generally a boss, supervisor, or personnel manager) probably had better knowledge of time spent in formal training and informal training by supervisors than of time spent in other forms of training. This should have resulted in the coefficients on these forms of training having a smaller measurement error bias than the coefficients on informal training by co-workers and time spent watching others. Thus, correcting for measurement error might raise the coefficients on these last two forms of training by more than it raises the coefficients on formal training.

8. Using a single logarithm of training hours variable to predict the productivity growth ratio, Barron, Black and Loewenstein (1989) obtained an elasticity of .11 (using the same metric as that used in the linear model in Table 9). The major differences between the two analyses are: (a) Barron et. al. predict productivity growth from the first 3 months average

to the end of 2nd year while this analysis predicts productivity growth from the first 2 weeks to the end of the 2nd year, and (b) length of training was not controlled by Barron et. al. whereas it is controlled in this analysis. It is this second difference that probably accounts for the somewhat larger elasticities in their analysis. The logarithmic model yields elasticities of the productivity level of .148 with respect to training intensity and .06 with respect to length of training.

9. Mincer (1989), for example, attempts to calculate a rate of return to the worker's investment in training by dividing the percentage wage increase by estimates of the cost of training (generally running between .2 and .25 of a years productivity) that are based on the fraction of a years time that worker's report they spend in training. This fraction tells us something about the combined employer and employee costs of training not the costs incurred by the trainee. In fact, in the Lillard and Tan (1986 Table 4.3 and 4.5) earnings regression which Mincer uses to estimate the depreciation rate for training, trainees experienced no earnings reduction during the year in which training was received. Similar results have been obtained in other data sets (Parsons 1985, Bishop and Kang 1988, Barron, Black and Loewenstein 1989). While the positive association between current training and current earnings is probably due to the omission of unobserved worker quality, it strains credibility that the true earnings sacrifice is 20-25 percent of a years wages when multivariate models that include schooling, test scores, actual work experience and a host of other variables indicate a positive effect of current training on current wages. The worker's investment in training is probably much smaller so the wage ROR for worker investments in training is probably much higher than the numbers estimated by Mincer.

10. If training intensity in each of the other seven quarters were identical to the first quarter's training intensity, the cost multiplier would be seven rather than two. The correct multiplier is significantly less than seven because training investments in the later period are not perfectly correlated with training investments in the first quarter and because most employers report the training period to be less than 6 months. Given these facts, the two for one ratio is an assumption that magnifies the cost of the reported differences in training intensity quite dramatically and reduces calculated rates of return by a factor of three.

11. As with productivity growth, estimation using instrumental variables increases the size of coefficients (probably because of the correction for measurement error in training) but decreases their statistical significance. In the IV models wage effects of training are much larger than the productivity effects.

12. Becker clearly recognized the existence of liquidity constraints in his 1962 paper. "Since employer specific skills are part of the intangible assets or good will of firms and can be offered as collateral along with tangible assets, capital would be more readily available for specific than for general investments (p.42)." He did not, however, explicitly analyze how such constraints might effect the predictions of his model.

13. Flanagan argues that the increasing number of wrongful discharge cases being won by plaintiffs with large jury awards has significantly raised the risks and costs of dismissing workers in the US. This may be the case for senior employees but such cases are seldom brought when the dismissal comes in the first two years of employment. Rates of turnover of workers with more than 5 years of tenure do not appear to be appreciably higher in the US than in Europe (OECD 1984)