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Abstract
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Keywords
CAHRS, ILR, center, human resource, job, worker, advanced, labor market, satisfaction, employee, work, manage, wage profile, wage, training, on the job, productivity, tenure, union, contract. flat wage profile

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WHY ARE WAGE PROFILES SO FLAT DURING THE FIRST YEAR ON A JOB?

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Working Paper # 89-18

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ABSTRACT

This paper presents evidence that productivity net of general training costs rise 4 or 5 times more rapidly than wage rates during the first 2 years on a job. This occurs for three reasons. First, sorting, high job search costs and the reputational damages that result from premature separations cause workers to prefer front loaded compensation packages which reduce the likelihood of involuntary terminations. Second, due to progressive income taxation and poor access to credit, workers discount the future more heavily than employers. Front-loading compensation is, therefore, a relatively cheap way for employers to attract top quality new hires. Finally, the minimum wage and union contracts also tend to force flat wage profiles.
WHY ARE WAGE PROFILES SO FLAT DURING THE FIRST YEARS ON A JOB?

One of the central propositions of the human capital theory of on-the-job training is that workers pay for and receive all the benefits of general training. Since general training raises a worker's ability to be productive in other organizations as well as the one providing the training, training firms must pay a wage commensurate with the trained worker's new higher level of productivity if they are to prevent the loss of their trained workers. Since the workers, not the firm, get the benefits of the training, "firms [will] provide general training only if they [do] not have to pay any of the costs" (Becker 1962 p. 13). Since the training is of value to prospective trainees, equilibrium in the training market requires that "employees pay for general on-the-job training by receiving wages below what could be received elsewhere" (Becker 1962 p. 13) in a job offering no training. Thus, the theory predicts that when training is general, each worker's wage must equal that worker's productivity net of training costs (the opportunity costs of the time others spend training the employee). Since training investments typically diminish with tenure, wage rates should rise more rapidly than productivity as tenure increases.

Lazear's (1981) agency model of employment contracts provides still another reason for expecting very low initial wages which then rise rapidly with tenure. In jobs where effort is difficult to monitor, this model predicts that workers are initially paid a wage that is below productivity net of training costs in order to generate a performance bond. The purpose of this bond is to insure that anyone fired for shirking suffers a serious loss, one that is great enough to deter shirking. The employees who are retained by the firm have this performance bond repaid to them in the form of a wage in the final period which exceeds the worker's productivity. As a result, wages rise more rapidly than productivity net of training costs.

This paper presents evidence contradicting the general validity of these predictions. It argues on both theoretical and empirical grounds that during the first year or so of a worker's tenure, wages rise more slowly than productivity net of training costs when training is entirely general. Many employers are induced to behave as if they were sharing the costs and benefits of general on-the-job training with their employees. This occurs for three reasons. First, sorting, high job search costs and the reputational damages that result from premature separations make a dismissed worker's next best
alternative decidedly unattractive and this causes workers to prefer front loaded compensation packages which reduce the likelihood of involuntary terminations. Second, since most young workers want to shift consumption from the future into the present but can borrow only at prohibitively high interest rates, employers take advantage of their better access to credit to front load the compensation package, in effect offering new hires a loan which is forgiven if the worker leaves. Finally, the minimum wage and union contracts prevent young workers from agreeing to the low starting wages that would be necessary if they were to self-finance general on-the-job training.

The first section of the paper offers a theory of wage profiles and training decisions which explains why the first two of these factors cause compensation to be front loaded. The second section evaluates the substantive importance of these explanations of front loaded compensation packages and proposes to test this theory by comparing wage growth in the first year of tenure on a job to the growth of productivity net of training costs. The third section of the paper reviews previous empirical research comparing rates of growth of wages and productivity. Section 4 describes a unique data set from which it is possible to derive estimates of the relative growth rates of wages and productivity net of training costs early in a worker's tenure at a firm. Section 5 compares the calculated growth rate of productivity net of training costs to the growth of real wages with tenure for jobs whose training appears to be predominantly general. The paper concludes with a summary and discussion of policy implications.

The theory to be presented owes much to Hashimoto's (1981) elegant formulation of how workers and firms share the costs and benefits of investments that are specific to a match between worker and firm. Sorting effects, transfer costs, turnover events as signals and differential access to capital markets are all incorporated into one model. Some of the important implications of the model as follows:

0. Match specific quasi-rents lower the second period wage below the worker's productivity in the firm and raise the first period wage by a compensating amount. Five different sources of match specific quasi-rents are identified: (1) specific training, (2) the damage to a worker's reputation from being fired or quitting, (3) the adjustment costs of finding another job and adjusting to it, (4) the improvement in the average productivity of the remaining workers that results from dismissing the least productive, and (5) the sorting effect that results from the exit of those with the best alternative opportunities and those who dislike their current job.
When elasticities of labor supply are greater for new hires than for trained workers with more than a year or so of tenure at the firm, the time pattern of compensation will reflect the relative rate at which employers and workers discount future earnings and the wage elasticities of voluntary and involuntary turnover. Since the young workers who need general training the most have only limited access to capital markets, they discount the future much more heavily than their employer and as a result compensation tends to be front loaded.

During the first year on a job a worker's productivity net of training costs grows much more rapidly than the wage even when training is completely general and employers, therefore, may appear to be sharing the costs and benefits of general training.

While some of these results have appeared in earlier papers (e.g., Parsons 1972; Glick and Feuer 1984), much of the recent wage growth literature appears to ignore the impact of differential access to capital markets, the reputational effects of a dismissal and specific human capital investments other than training on wage growth (Garen 1988). The purpose of this paper is to point out just how important these effects are by incorporating these factors in a formal model and then by reviewing empirical literature on transition costs and liquidity constraints to show that when reasonable assumptions are made about their magnitude, big changes occur in predicted rates of wage growth during the first year on the job.

I. THEORY

The firm's training level and wage profile will be analyzed in a simple two period model. Training is assumed to produce two types of skills: general skills \((g)\) which are useful at other firms and specific skills \((h)\) which are productive only at the firm providing training. The cost of the training \(C(g,h)\) are incurred in the first period and the benefits are received in the second period. There are two random elements in the model. The first is the utility that a worker can attain by leaving the firm at the beginning of the second period, and the second is the worker's second period productivity in this firm after the training is completed. We assume that wages and productivity in the two periods are the following.

<table>
<thead>
<tr>
<th>Worker</th>
<th>Productivity</th>
<th>Worker</th>
<th>Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st period at the firm</td>
<td>(P)</td>
<td>2nd period at the firm</td>
<td>(P + g + h + \epsilon_o)</td>
</tr>
<tr>
<td>2nd period at other firms if quit</td>
<td>(U(g) - T + \epsilon)</td>
<td>2nd period at other firms if fired/laidoff</td>
<td>(U(g) - T - F_b + \epsilon)</td>
</tr>
</tbody>
</table>
where

\( P \) is the worker's productivity without training

\( g \) is the increment in productivity due to general training

\( h \) is the increment in productivity at the firm due to specific training

\( \epsilon_0 \) is the random factor in productivity in this firm which captures one element of the quality of the match at the training firm

\( W^1, W^2 \) are the first and second period wages at the firm

\( U(g) + \epsilon \) is the utility of the best alternative job if one leaves voluntarily. This depends on the amount of general skill and a random factor which measures from the worker's point of view the quality of the firm-worker match at the alternative firm relative to the match at the training firm.

\( T \) is the costs of transition if the change in jobs is initiated by the worker: moving costs, reputational damage from having the quit signal on one's resume, lost income while waiting for the next job to start.

\( F_b \) the additional transition costs imposed on the worker over and above \( T \), if the exit is involuntary: the additional damage to the worker's reputation from being permanently laid off or fired rather than leaving voluntarily, the lost income due to the wait until another job is found.

Turnover decisions are made in two stages. At the end of the first period, the worker makes the first move by deciding whether to quit or to express an intention to stay. If the worker quits, he/she obtains a job which offers a utility level of \( U(g) - T + \epsilon \). The worker but not his employer learns about \( \epsilon \) at the end of the first period.

Then the firm decides whether to keep or dismiss the worker by comparing the second period wage to the worker's productivity in the firm, \( P + g + h + \epsilon \). If the worker's productivity is less than the second period wage, the firm will dismiss the worker. The random factor \( \epsilon_0 \) is a measure of the quality of the firm-worker match at the current firm. If the worker is dismissed at this stage he/she will be forced to look for work while unemployed and will incur an additional transition cost of \( F_b \). Therefore, the worker's first stage decision will take into account the risk of involuntary turnover in the second stage.

At the beginning of the first period neither the worker nor the firm knows the worker's exact productivity in this firm and in other firms. The firm offers wage package \( (W^1, W^2) \) based on information obtained in the interview and from references and the nature of uncertainties involved, i.e. the probability density function's of \( \epsilon_0 \) and \( \epsilon \). In the first period, the firm trains the
worker, taking into account the possible loss of the investment due to a separation in the next period. Training investment takes two forms, investment in firm specific skills and general skills. General training increases the wage that the worker can obtain in alternative employment as well as his productivity in this firm. Workers accept the job offer from this firm if the wage package and training plan are generous enough to attract workers in a competitive labor market. In deciding, the worker takes account of possible gains or losses from a voluntary or involuntary separation. We assume the worker and the firm have the same prior distributions on the uncertainties surrounding the worker's productivity in this firm and worker's income opportunity outside the firm in the second period. Further, we assume that both the firm and the worker are risk neutral.

The firm's objective is to maximize the discounted sum of profit from the two periods by choosing wage rates in two periods, $W_1$ and $W_2$, and an amount of general training, $g$, and specific training, $h$, subject to the constraint that the wage offer and amount of training are generous enough to attract new hires in a competitive labor market. The firm's expected profit maximization problem when $\epsilon$ and $\epsilon_0$ are independent is written as:

$$
\text{(1) Max } P - C(g,h) - W_1 + \delta_a [\Pr(S)\Pr(K)(P + g + h + E(\epsilon_0|K) - W_2)] \\
g, h, W_1, W_2 \\
\text{Subject to the constraint}

\text{(2) } R \leq W_1 + \\
\delta_b [\Pr(S)\Pr(K)W_2 + (1-\Pr(S))(U-T+E(\epsilon|Q)) + \Pr(S)(1-\Pr(K))(U-T+E(\epsilon|S)-Fb)]
$$
or

$$
R \leq W_1 + \delta_b [\Pr(S)\Pr(K)(W_2 - U + T - E(\epsilon|S) - \frac{1-\Pr(K)}{\Pr(K)}Fb) + U - T]
$$

where

- $E(\epsilon_0|K)$ is the conditional expectation of $\epsilon_0$ given that the firm wishes to keep the worker.
- $E(\epsilon|Q)$ is the conditional expectation of $\epsilon$ given that the worker quits the firm.
- $E(\epsilon|S)$ is the conditional expectation of $\epsilon$ given the worker wishes to stay in the firm. $E(\epsilon|S) < 0$.

$\delta_a$ and $\delta_b$ are fixed discount factors of the firm and worker, respectively.

$\Pr(S)$ is the prior probability the worker is willing to stay with the firm.
Pr(K) is the prior probability the firm is willing to keep the worker.

R is the level of expected utility the worker can attain in the competitive labor market.

At the end of the first period, the worker learns what utility can be obtained by taking a job at another firm. Based on this information, the worker's decision rule is:

\[
\text{STAY IF } Pr(K)W^2 + (1-Pr(K))(U-T-F_b+\epsilon) > U - T + \epsilon
\]

The right-hand side of the inequality is the utility level of the alternative job. It is affected by the amount of general training that other employers perceive the worker to have obtained, \( g \), and the costs of making a voluntary transition, \( T \), and the random term, \( \epsilon \), which captures the worker's relative evaluation of two jobs. The left-hand side of the inequality is the expected income if he/she wishes to stay at the firm. Note that the expected income of choosing to stay takes into account the risk of being fired or laid off and suffering the additional transition costs \( F_b \) that involuntary turnover imposes on the worker. The probability of a worker wishing to stay in the firm, \( Pr(S) \), is:

\[
Pr(S) = Pr(\epsilon \leq W^2 - U + T - \frac{1-Pr(K)}{Pr(K)}F_b)
\]

\[
- \Phi(W^2 - U + T - \frac{1-Pr(K)}{Pr(K)}F_b)
\]

where \( \Phi \) is the cumulative density function of \( \epsilon \).

Note that the argument for the cumulative density function, \( \Phi \), contains the term \(-\frac{1-Pr(K)}{Pr(K)}F_b\), which is minus the odds of being laid off or fired times the additional transition costs, \( F_b \), that result from involuntary turnover. This implies that if a worker believes there is a high probability of being laid off or fired, he is more likely to quit.

By the end of the first period, the firm knows the worker's productivity in the second period and whether the worker wants to stay. It then lays off or fires the worker if \( P+g+h+\epsilon_0 \) is less than the second period wage. Consequently, \( Pr(K) \) is written as

\[
Pr(K) = Pr(P+g+h+\epsilon_0 > W^2)
\]

\[
= 1 - \Phi_0(W^2-P-g-h)
\]

where \( \Phi_0 \) is the cumulative density function of \( \epsilon_0 \).
Denoting the probability density function of $\varepsilon$ and $\varepsilon_o$ by $\phi$ and $\phi_o$, the first order condition for the second period wage is written as:

$$0 = \delta_a \left( \frac{\partial \Pr(S)}{\partial w^2} \Pr(K) Q_a - \Pr(S) \Pr(K) \right) + \delta_b \left[ \Pr(S) \Pr(K) - \phi_o \Pr(S) Q_b \right]$$

where $Q_a$ and $Q_b$ are defined as

$$Q_a = P + g + h + E(\varepsilon_o | K) - w^2 > 0,$$
$$Q_b = w^2 - (U(g) - T - F_b + E(\varepsilon | S)) > 0.$$

$$\frac{\partial \Pr(S)}{\partial w^2} = \phi(1-v)$$
$$v = \frac{\phi_o}{\Pr(K)^2 F_b} = \frac{\eta K \phi_o}{Pr(K)}$$

$\gamma_k$ is the elasticity of the firm's keep rate, $\Pr(K)$, with respect to the 2nd period wage times minus one. $\eta_k = \phi_o w^2 / \Pr(K) > 0$.

$f_b = F_b / w^2$ is the ratio of the transition cost if fired to the 2nd period wage.

$Q_a$ is the firm's expected profit on workers who want to stay with the firm and which the firm wants to keep. Alternatively, it is the employer's share of 2nd period quasi-rents. $Q_b$ is the gain the worker receives from not being dismissed or alternatively the worker's share of 2nd period quasi rents. It is the difference between the second period wage, $w^2$, and expected utility if dismissed, $(U(g) - T - F_b + E(\varepsilon | S))$. Note that $\phi_o / \Pr(K)^2$ is the derivative of the odds of being kept with respect to the second period wage. An increase in the second period wage has two effects on the worker's decision to stay. The direct effect increases the desire to stay. The second effect is that it raises the odds of being permanently laid off or fired and incurring the added transition costs $F_b$. While this second effect lowers the probability of staying, we may reasonably assume that the total effect of a wage increase on $\Pr(S)$ is positive, (i.e. $0 < v < 1$) because the elasticity of the keep rate, $\gamma_k$, is not likely to exceed 1 and the extra transition cost of an involuntary termination is probably less than 20 percent of the 2nd period wage.

The first order conditions for specific and general training ($h$ and $g$) are given by (6) and (7).

$$C_h = \delta_a \Pr(K)[\Pr(S) + (\partial \Pr(S) / \partial h) Q_a] + \delta_b \Pr(S) \phi_o Q_b$$

where $C_h = \partial C / \partial h$, $\partial \Pr(S) / \partial h = \phi v$,

$$C_g = \delta_a \Pr(K)[\Pr(S) + (\partial \Pr(S) / \partial g) Q_a] + \delta_b [(1 - \Pr(K) \Pr(S)) U_g + \phi_o \Pr(S) Q_b]$$

where $C_g = \partial C / \partial g$, $U_g = 1$, $\partial \Pr(S) / \partial g = \phi (-U_g + v)$
These conditions can be more simply represented by:

\[(6') C_h = \delta_a Pr(SK)[1 + \gamma_s v q_a] + \delta_b Pr(SK)\gamma_k q_b \]

\[(7') C_g = \delta_a Pr(SK)[1 + \gamma_s (v-1) q_a] + \delta_b [(1 - Pr(SK)) + Pr(SK)\gamma_k q_b] \]

where

- \(Pr(SK) = Pr(S)Pr(K)\) is the probability the worker is at the firm in the second period
- \(q_a = Q_a/W^2\), the ratio of the firm's quasi rent to the 2nd period wage
- \(q_b = Q_b/W^2\), the ratio of the worker's quasi rent to the 2nd period wage
- \(\gamma_s\) is the elasticity of the worker's stay rate with respect to the 2nd period wage. \(\gamma_s = \phi (1-v) W^2/Pr(S) > 0\).

The first order condition for specific capital, \((6')\), says that the marginal cost of investment in specific capital is equated to the marginal discounted revenue to the firm, the discount factor times the retention rate and the marginal increase in the stay rate resulting from the reduced probability of being terminated involuntarily times the share of the second period wage that is a quasi rent for the employer, \(\delta_a Pr(SK)[1 + \gamma_k v q_a]\), plus the discounted marginal benefit to the worker of the specific training. The benefit of specific training to the worker is captured by the second term of \((6')\). The increased productivity makes the firm less likely to dismiss the worker. This effect is captured by \(\gamma_k\), the elasticity of the keep rate with respect to the second period wage. In \((6')\) \(\gamma_k\) is multiplied by \(q_b\), the share of the second period wage that is a quasi rent for the worker.

Also the optimal wage in the first period, \(W^1\), is determined so that the constraint (2) is binding. The first order conditions--(5), (6), (7) and (2) with equality constraint--characterize the optimal wage-training package the firm will offer. Substituting first order conditions for \(W^2\) into the condition determining the level of general human capital investment and rearranging terms, we get the familiar condition in which the marginal cost of general training is equated to the worker's discount factor:

\[(7'') C_g = \delta_b \]

In what follows, we examine the implications of these conditions for the wage profile.

**Choosing the Wage Profile**

Making use of the assumption that competitive equilibrium implies that
the expected profit from hiring the marginal worker is zero, the optimal wage rates for the two periods may be written as follows:

\[
W^2 = [P + h + g + E(\epsilon_0|K)] - \theta [h + T + F_b + E(\epsilon_0|K) - E(\epsilon|S)] - \frac{(\delta_a - \delta_b)h^2}{\delta_a \gamma_a + \delta_b \gamma_b}
\]

\[
W^1 = P - C(g,h) + \delta_a Pr(S)Pr(K)(\theta [h + T + F_b + E(\epsilon_0|K) - E(\epsilon|S)] + \frac{(\delta_a - \delta_b)h^2}{\delta_a \gamma_a + \delta_b \gamma_b})
\]

where \( \theta = \frac{\delta_b \gamma_b}{\delta_a \gamma_a + \delta_b \gamma_b} \) is the employer's share of the costs of specific human capital investments and of quasi rents.

Equation (8) implies that the expected profit from the worker staying with the firm is positive. Since in long run equilibrium, competition among firms brings the expected profit of the firm to zero, the wage rate in the first period must be higher than the worker's productivity net of training cost by a compensating amount. Thus our model predicts that in the early stage of employment, productivity net of training cost grows faster than the wage rate. The firm's net profit is negative in the investment period but the loss is compensated in the second period when the firm receives the return from human capital investment.

The wage offer in the second period is the expected productivity of the worker, \( P + g + h + E(\epsilon_0|K) \), less the second and third terms in (8). The expression in the second set of brackets is the difference (for those who are kept and want to stay) between the worker's productivity in the firm, \( P + g + h + E(\epsilon_0|K) \), and the utility of the worker's best alternative job if he/she is laid off or fired, \( P + g - T - F_b + E(\epsilon|S) \). The second term indicates that given the value of \( \theta \), the following factors raise the firm's first period wage offer and reduce the firm's second period wage offer:

- Transition costs if the exit is voluntary, \((T)\)

- The additional transition costs of the worker resulting from being laid off or fired, \((F_b)\)

- The average unattractiveness of alternative employment for workers who want to stay, \((-E(\epsilon|S))\).

Costly investments in firm specific training—eg. \( h \) for which \( C(h) = h \)—lower first period wages by less than the costs of training, increase second period wages by less than the productivity benefits of training and increase rates of wage growth by less than the resulting increase in productivity net of training costs.
Costless increases in second period firm specific productivity tend to raise wage offers in both the first and the second period. In the context of this model the factors which improve the firm specific productivity of workers in the second period without raising costs during the first period are:

-- Firm specific learning by doing \([h^d] \text{ for which } C(h^d) = 0\); and

-- The firm's expected gain from having the option of dismissing less productive workers, \((E(\varepsilon_0|K))\).

These two factors have an ambiguous effect on the rate of wage growth. An increase in the importance of either of these two factors will lower the rate of wage growth if: \(\delta_a \Pr(S) \Pr(K) \theta > 1 - \theta\).

Also, other things being equal, first period wage offers rise and second period wage offer decline if \(\theta\), the employer's share of quasi rents, is increased. Factors that makes \(\theta\) larger are:

-- The wage elasticity of the keep rate increases relative to the elasticity of the worker's willingness to stay at the firm. (ie. \(\gamma_k\) is large relative to \(\gamma_s\)). This could be caused by \(\phi_0\) being large relative to \(\phi\) or by \(v\) being close to 1.

-- High incremental transition costs when turnover is involuntary, \((F_b)\), result in workers becoming so fearful of dismissals that they prefer contracts in which employers finance a larger share of firm specific investments so as to reduce their risks of dismissal. If \(F_b\) is large relative to \(W^2\), \(v\) becomes larger.

-- The worker's valuation of future earnings grows relative to the firm's valuation. (ie. \(\delta_b/\delta_a\) becomes larger).

Workers must pay higher interest rates when they borrow than employers and also tend to face higher marginal tax rates during the payoff period than the training period. The third term of (8) and (9) represents the effects of their consequent tendency to discount future returns more heavily than employers. Since the error term in the quit relationship does not have a degenerate distribution, the supply of trained labor is not infinitely elastic. Bloch (1979) cross section analysis of turnover in 49 manufacturing industries, for example, found wage elasticities of -1.3 for quit rates and .85 for the layoff rates when the lagged accession rate was included in the model. The supply of untrained labor, however, is assumed to be infinitely elastic at \(R\). New hires take second period wages into account when evaluating the firm's job offer, however, so the decline in the elasticity of labor supply with the worker's tenure influences the wage structure only when the firm and its workers discount the future at different rates. The compensation packages reflect the worker's preference for compensation now rather than
later. Thus, the third term of (8) and (9) implies that the firm's second period wage will be reduced and the first period wage increased to the extent that:

-- The firm's discount factor is large relative to the worker's discount factor, \((\delta_a - \delta_b)\) is large.

-- The elasticities of the worker's stay rate, \(\gamma_s\), and of the firm's keep rate, \(\gamma_k\), with respect to the firm's second period wage are small.

III. The Magnitude of Transition Costs and Differential Time Preference Effects

Quasi Rents Generated by Sorting, Job Search Costs and Damaged Reputations

In most matches between a worker and a firm there is a substantial difference between the average productivity of workers who stick with the firm and the expected utility of alternative employment of those who wish to stay at the firm but are nevertheless terminated involuntarily. This difference, the quasi rent associated with the match, is given by the expression:

\[
(10) \quad \text{Quasi Rent} = [h + T + F_b + E(\epsilon_0|K) - E(\epsilon|S)] - Q_a + Q_b
\]

By sharing these quasi rents, both parties try to induce the other to maintain the contract. The 2nd, 3rd, 4th and 5th terms inside the bracketed expression are often quite large. Even when training is entirely general (\(h=0\)), this makes it optimal for the firm to pay wages which exceed productivity minus training costs in the first period and to offer a wage in the second period which is correspondingly lower than productivity in the second period. The rate of wage growth is considerably below the rate of growth of productivity net of training costs and the firm appears to pay part of the costs of general training. Nevertheless, marginal increases in general training do have the effect on the wage structure predicted by Becker--starting wages decline by the incremental costs of the increased general training and second period wages rise by the full amount of the increase in worker productivity. Workers do not appear to be paying the full costs of their general training because employers are offering to share some of the risks attached to the new
relationship--transition costs and reputational damage from possible dismissals--and because the employer is in effect lending the worker money.

**Transition Costs-Job Search and Reputations**

The substantive importance of the points just made depends on just how large the transition costs, T and F_b, are. The transition cost T is in part adjustment costs such as moving costs and the unhappiness resulting from losing friendships at work. A second reason why T is expected to be positive is that, for most workers, a quit damages one's reputation. A quit after a short time on the job is likely to be interpreted as a signal of problems that may recur, a lack of commitment to one's job or a high quit propensity. Hollenbeck and Smith's (1984) study of employer reactions to resumes found that the number of quits in the job history had a large negative effect on the rating assigned to the job applicant.\(^1\)

The third term of the quasi rent expression, F_b, is the additional costs associated with involuntary terminations. Such terminations are very costly for the worker because (1) finding another job takes a great deal of time and is psychologically stressful and (2) a discharge does even more damage to a worker's reputation than a quit. Involuntarily terminated workers seldom have another job lined up so they immediately enter the ranks of the unemployed. Dynarski and Sheffrin (1987) have calculated that the expected length of a spell of unemployment was 10.3 weeks in 1980-81 for the household heads in the Panel Study of Income Dynamics data. Using 1974 CPS data, Clark and Summers (1979) calculated that if unemployed workers did not leave the labor force, it took on average 12.6 weeks for teenagers to find another job and 16.2 for those over 20 years of age to find another job. Blau and Robins' (1985) analysis of longitudinal data from the Employment Opportunity Pilot Projects found that it took on average 25 to 36 weeks for unemployed welfare recipients to find a job and 15 to 20 weeks for unemployed workers not on welfare to find a job.\(^2\) If the termination is a dismissal or a layoff occurring after only a few months on the job, the individual may not be eligible for unemployment insurance. These costs are the natural consequences of involuntary turnover. They have not been generated by implicit contracts in which workers are required to put up a bond against shirking.

When they find another job, it typically pays less. In the National Longitudinal Survey, young men who changed employers between 1967 and 1973 subsequent to an involuntary separation experienced a 3 percent decline in their wage rate over the two year measurement period. For the mature men's sample the wage decline was 10 percent. These effects appear to persist for
many years. Models were estimated in which dummies for a separation between
1969 and 1971 were used to predict wage growth during 1967-69 and 1971-73 as
well as for 1969-71. The workers who were involuntarily terminated between
1969 and 1971 experienced a sharp deceleration in their wage growth which
persisted into 1971-73 (Bartel and Borjas 1981). Analyzing a five year time
interval in PSID data, Ruhm (1987) found that involuntary terminations lowered
the wage growth of male household heads by 13.6 percent but had no significant
effect on the wage growth of female household heads. These wage reductions
arise partly because the individual's specific human capital is now worthless,
partly because of Lazear type bonding contracts (if they do indeed exist for
young workers) and partly because quits and dismissals are signals which
damage the worker's reputation.

The unemployment durations and wage reductions reported above are for all
involuntarily terminated workers as a group. While no study reported separate
estimates of the effects of discharges and layoffs, one suspects that those
discharged experience longer spells of unemployment and bigger wage declines
than those laid off. Many employers contact a job candidate's previous
employers prior to making a final hiring decision and, therefore, may
learn of the discharge. If the job seeker does not include the employer who
discharged him in his employment history, there is a long stretch of
nonemployment that must somehow be explained. Discharged employees are
reported to be 25 percent less productive than the workers who end up staying
with a firm for a year or more (Bishop 1988). In some cases this productivity
disadvantage is specific to the match, but it is difficult for other employers
to assess whether that is the case so if they know a job applicant was fired
by a previous employer, they are unlikely to hire him/her.

Since the costs of an involuntary termination are so severe, job seekers
would be expected to prefer employers and employment contracts which minimize
risks of discharge and layoff and which promise that bad recommendations will
not be given. Promises not to give bad oral recommendations are not
enforceable, however, so the worker's only recourse is to seek contracts which
minimize the risk of dismissal and layoff. Seniority protection, grievance
procedures and enforceable promises to dismiss a worker only after certain
procedures are followed are one way to accomplish this but in nonunion
settings there are always ways of forcing an unwanted employee out. A more
reliable way of reducing the risk of dismissal and layoff is to have the
employer put up a bond which is forfeited if the worker is laid off or
dismissed. Workers, therefore, prefer employment contracts containing a front
loaded compensation package. There are, of course, countervailing forces such as the desire to reduce the number of trained employees who quit, so the form of the contract depends on how the various forces balance out.

The fourth and fifth terms of the bracketed expression capture the effect of sorting on the quasi rent. As the worker and the firm learn more about the quality of the match, the unsuccessful matches tend to be terminated. The workers who discover that they do not like the job or that they have better opportunities elsewhere quit and the workers who are the least productive on the job are fired or induced to quit. Thus, even when training develops only general skills and there are no transition costs, the expectation of the difference between the productivity of workers who stick with the firm and their evaluation of the next best alternative—the quasi rent attached to the match—is considerably greater for long tenure workers than for recent hires. Sorting's effect on average productivity has been estimated to be at least 2.6 percent between the fourth and seventeenth month on the job at small and medium sized non-union firms (Bishop 1988). Sorting is also generated by differences in tastes for the nonpecuniary features of a job and differences in alternative opportunities. Consequently, sorting probably causes quasi rents equal to 4 to 8 percent of yearly compensation. Transition costs probably generate quasi rents equal to another 5 or 10 percent of compensation. The growth of these quasi rents during the first year causes wage growth to diverge from the growth of productivity net of training cost. If \( (T + F_b + E(\epsilon_0|K) - E(\epsilon|S)) \) is 10 percent of compensation in the second period, a \( \theta \) (the employer's share of specific investments) of .5 implies that second period wages are reduced by 5 percent and a \( \theta \) of .8 implies they are reduced by 8 percent. If the investment and payoff periods are of equal length, wage growth will be \( \theta[1 + \delta_a Pr(S)Pr(K)](\cdot10) \) less than the growth of productivity net of training costs. With a discount factor of .9, a retention ratio of .7, wages rise 8.1 percent less than productivity net of training costs when \( \theta \) is .5 and rise 13.1 percent less when \( \theta \) is .8. If the payoff period is twice as long as the investment period, the reduction in percentage growth is 11.2 percent when \( \theta \) is .5 and 18.3 percent when \( \theta \) is .8. Clearly, transition costs and sorting effects can have significant effects on the time pattern of compensation in the first year or so of a job.

The magnitude of quasi rents vary across workers so the supply of trained labor with respect to their wage is not infinitely elastic. Consequently, while preventing other firms from hiring away trained labor is an important objective in setting the second period wage, there is room for
other factors to play a role as well (Glick and Feuer 1984). The other
factors that can now influence the wage profile are differences in access to
capital markets, differences in marginal tax rates and constraints on wage
setting due to unions and wage minimums.

The Effects of Differential Access to Capital Markets

The second force tending to lower wage growth below the growth of
productivity net of training costs is the fact that most workers receiving
substantial amounts of general training discount the future much more heavily
than their employers. This force is represented by the term on the far right
hand side of equations 7 and 8 where it results in $\delta_a - \delta_b > 0$. Most young
workers (the ones who have the greatest need for general training) have
neither assets which can be depleted (to maintain consumption at acceptable
levels during general training) nor access to credit at reasonable terms.
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 (Hubbard and Judd 1986). Even with collateral, the
loans available to individuals usually carry higher interest rates than those
charged businesses.

Progressive Taxation

In addition, the progressive nature of the personal income tax means that
workers face higher marginal tax rates on the fruits of training investments
than they are paying when they incur the costs of such investments. Firms, on
the other hand, train continuously, so the marginal tax rates faced when the
costs of training are incurred and expensed are no different from those faced
during the payoff period.

These two factors result in firms being more willing than workers to
trade off future earnings for present earnings. The compensation packages
that result from the asymmetric access to capital markets and the progressive
tax structure reflect the worker's strong preference for compensation now
rather than later. If, for example, $\delta_a = .9$, $\delta_b = .75$ and both $\gamma_a$ and $\gamma_b = 1$, the second period wage is reduced by 9.1 percent. If the two time periods are of equal length, the first period wage is increased by 5.7 percent and wage growth is reduced by 14.8 percent. If the wage elasticity of keep rates and stay rates is doubled to 2, then the wage growth effect is cut in half to 7.4 percent. If the payoff period is double the length of the investment period, the wage growth is reduced by 20.5 percent when wage elasticities, $\gamma_a$ and $\gamma_b$, are 1 and by 10.2 percent when wage elasticities are 2. In effect, firms offer new hires a loan that will be canceled if a separation occurs. Firms do not require repayment of the loan when separations occur for the same reasons that banks do not offer large unsecured loans without a government guarantee of payment. The administrative costs of obtaining repayment are extremely high and bankruptcy is a real option for someone with zero assets.

**Constraints on Wage Setting: Legal and Contractual**

The third force that tends to lower wage growth below the growth of productivity net of training costs is legal and contractual constraints on the starting wage rate. For entry level jobs obtained by young workers, the minimum wage is an important source of such rigidity in the United States and in those European countries with similar legislation (Hashimoto 1982). In European countries that have lower minimum wages for youth (e.g. Netherlands) or no governmental legislation (e.g. Germany) and in adult jobs where legislated minimums are not a binding constraint, collective bargaining agreements are an alternative mechanism for mandating a flat wage profile. Most unions appear to prefer flat wage profiles. The motive might be to maintain solidarity between workers or to restrict access to the occupation by discouraging the provision of general occupational training. The reasons for a collective worker preference for flat wage profiles is not analyzed, the desire is treated as an exogenous constraint on the structure of an optimal contract.

Thus, our model offers three different reasons why wages may rise less rapidly during the first year on the job than productivity net of training costs when training is entirely general. The theory of general on-the-job training predicts, instead, that when training is entirely general (i.e. h=0), wages will rise at the same rate as productivity net of training costs. The Salop/Salop (1976) and Nickell (1976) adverse selection models predict that wages will rise at the same rate as productivity net of training costs even when much of training is specific to the firm. Agency theory goes even further and predicts that wages will grow more rapidly than productivity net
of training costs when training is entirely general. Consequently, a comparison of these growth rates is a natural and powerful way to test the efficacy of these competing theories. This paper provides such a comparison of wage and productivity net of training cost growth rates during the first year on the job for a sample of 1493 workers hired by small and medium sized establishments during 1980 and 1981. The next section of the paper reviews previous empirical research on the subject.

III. Previous Research on the Effects of Tenure on Productivity and Wages.

Medoff and Abraham (1981) were the first to analyze data in which it is possible to compare the growth of wages and productivity with tenure. Using micro-data on long tenure employees from the personnel records of four large U.S. corporations, Medoff and Abraham found that, within a grade level, experience was positively associated with wage rates but negatively associated with performance ratings. They concluded that, "under the assumption that rated performance is a valid indicator of relative productivity, our results imply that a substantial fraction of the return to experience among the groups we are studying is unrelated to productivity" (p. 187). Medoff and Abraham also reviewed a number of other studies and concluded that the association between seniority in a job and productivity is curvilinear. During the initial very short orientation/training period there was a positive association. Once this training period was over, however, there tended to be a negative association between tenure and productivity among those who occupy a particular job (i.e., have not been promoted to greater responsibility). Almost all the studies were conducted in large corporations and almost all of the workers included in these studies had many years of tenure at the firm. These findings suggest that Lazear's agency model is one of the explanations of the rise of wage rates with tenure at large firms once the initial 1-5 year learning period is completed. It is not clear, however, that the finding that wages rise more rapidly than productivity extends to small firms or to workers with only a year or so of tenure. Small firms are significantly different from large firms. Turnover is higher in small firms and more contingent on performance so the sorting explanation of wage and productivity growth should be more relevant to small firms than to large firms (Bishop 1988). Monitoring problems are not as severe at small firms so Lazear's agency theory explanation for backloading compensation is less applicable at these firms. Reinforcing this is the fact
that small firms do not have well established reputations which might be
damaged by reneging on a Lazear type bonding contract. As a result, workers
may be reluctant to enter into such contracts with small firms. The
circumstances are also different in the first year of employment for turnover
is higher, training is greater and productivity is rising rather than falling.

In fact, there is an abundance of evidence that in the first few months
on a job, productivity rises dramatically while wages are rising only
modestly. Industrial engineers have found that the learning curve for many
jobs is such that new hires make almost no contribution to output for many
weeks and often take a year or more to reach the productivity standard (King
1964, Talbot and Ellis 1969). If all this learning were firm specific and
employers financed all of its costs, this pattern might be consistent with
standard theory. But standard models of the sharing of the costs of specific
training do not predict that employers pay all of its costs and, indeed,
adverse selection theory predicts that employers pay none of the costs of
specific training. The specific training explanation of the flat wage profile
is particularly suspect when to all outward appearances much of the training
is useful at other firms (as it is when a new secretary spends the first few
weeks on a job learning Word Perfect, a word processing program used by many
other employers).

Studies of who appears to pay the costs of apprenticeship training, a
form of training that is industry specific but not firm specific, in three
different nations--Germany, Great Britain, and the United States--all
contradict the claim that employers will only offer apprenticeship training
when the training wage is low enough and the apprenticeship period long enough
for the employer to recover all training investments by the end of the
apprenticeship (Atkinson 1982; Noll et al 1984; Ryan 1980; Jones 1985;
Weiderhold-Fritz 1985). Despite the transferable character of the training
and high turnover rates, these studies concluded that employers made large
investments that were not recovered during the apprenticeship. A welding
apprenticeship program at a major U.S. shipyard was the subject of the first
of these studies (Ryan 1980). The wage profile was quite flat--starting at
$3.99 and topping out at $5.26 after about two years on the job--even though
the investments in general training were very considerable. Inexperienced new
hires spent 36 days in vestibule training before beginning work. During the
first week following vestibule training, the trainee's output net of repair
requirements was less than 10 percent of an experienced worker's output.
Thirty-seven weeks after being hired it reached a level of 55 percent and at
60 weeks a level of 80 percent of an experienced workers output. Despite the fact that the local economy was in deep recession, monthly separation rates were extremely high: 10.8 percent for beginners and 6.3 percent for those with 12 to 24 months of tenure. The shipyard accounted for about one-fifth of the welding jobs in the area. When trained welders left the shipyard, they typically found better paying welding jobs at other local employers. This evidence clearly establishes that despite training being highly general, wage growth was substantially slower than the growth of productivity net of training costs. It appears that the shipbuilding company was contributing to the costs of general training.

The study of German apprenticeship training by the Bundersinstitut fur Berufsforschung found that in 1980 the employer share of apprenticeship training costs ranged from a high of 25,200 DM per year for telecommunications technician apprentices to 2400 DM for apprentice gardeners and averaged 10,300 DM or $5668 per year at 1980 exchange rates. The apprentice’s contribution to output, which was netted out to arrive at the above figure, averaged 6700 DM per year (Weiderhold-Fritz 1985). In Great Britain employers claimed "We pay them far more than they’re worth (Atkinson 1982 p. 9)." The employer’s share of training costs (net of apprentice contribution to output) was £3032 per year in engineering, £1180 per year in road transport and £1870 per year in construction. Even major upward revisions of estimates of the apprentice’s contribution to output would not change the basic conclusion that employers appear to be sharing the costs of general training. While the German and British studies have large enough samples to make generalizations possible, a case study of one occupation at one firm is much too small a data base for generalizations about the U.S. This paper tests whether Ryan’s case study finding can be replicated in a larger and more representative sample of U.S. jobs.

IV. Data

An employer survey sponsored by the National Institute of Education and the National Center for Research in Vocational Education conducted between February and June 1982 provides the basis for our test of these theories. Each of the 3412 surveyed employers was asked a series of questions about "the last new employee your company hired prior to August 1981 regardless of whether that person is still employed by your company." In order to minimize problems of recall and of adjusting actual starting wage rates for inflation
since the date of hire, the sample employed in this paper is a subset of 1493 employers who hired someone after July 1980 and answered all the questions about wage rates, productivity and training. Most of the respondents were the owners/managers of the small establishments (70 percent had fewer than 50 employees) who were quite familiar with the performance of each of the firm's employees.

The survey asked the employer (or in larger firms the immediate supervisor) to report on productivity of the typical individual hired in the job after 2 weeks, during the next 11 weeks and at the end of 2 years at the firm. The supervisor was asked to do the rating 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 the mean values of these indexes of reported productivity were 49.0 for the first 2 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 remarkably low 4.4 percent nonresponse rate.9

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 individual workers at different points in time. This is a crucial assumption and the sensitivity of results to changes in this assumption will be carefully examined. If 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 increases in productivity during the first year on the job will be biased downward. 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, our estimates of percentage increases in productivity during the first year will be biased downward. In our view, this latter type of bias is more likely than the former.10 The sensitivity of the main findings concerning the proportionality assumption will be tested by presenting estimates of the growth of productivity net of training costs that are based
on 3 alternative assumptions: proportionate differences in productivity are in fact 50 percent of those reported, equal to those reported and 150 percent of those reported.

Data were also obtained on the amount of time that is devoted to four different kinds of training activities during the first 3 months on the job. 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 3 months on the job.11

V. Results

The key issue is how the growth rates of wages and productivity net of training cost compare when training is predominantly general. Consequently, a measure of the generality of training is needed so that the sample of jobs for hypothesis testing can be limited to those which provide a great deal of general training. The question which provides us with such a measure is, "How many of the skills learned by new employees in this job are useful outside this company?" Fifty-nine percent responded "almost all," 13 percent responded "most," and only 7.5 percent answered "almost none." The employers were next asked how many other local firms made use of the general skills that were developed in their training. The jobs that offer the most general skill training are defined to be those reported to have "almost all" of their skills useful at other firms and 16 or more other firms in the local labor market that in fact use these skills. Data for these jobs are presented in the first column of table 1. The second column presents data for the jobs where almost all of the training was useful in other firms, but here the number of such firms in the locality was small enough (below 16) to suggest that employers might have some monopsony power. The groupings for the other three columns are based only on the generality of the skills developed without regard to the size of the local market for these skills.

The first two rows of the table present estimates of the real wage increase in the first one or two years at the job.12 The starting wage is for a period averaging 13 months prior to the interview, so real wage increases were calculated by dividing the actual wage increases reported for the sampled new hires by 1.071, the increase in the economy wide hourly wage (excluding overtime) between April 1981 and May 1982. Jobs which offer training in skills which are at least in part useful at other firms appear to command real wage increases of only 5 to 6 percent in the first year and 2 to 6 percent in the second year at the job (see columns 1 to 4). The increase in the real
wage is much smaller (essentially zero for the two year wage growth figure) in the jobs involving highly specific skills (see column 5). Thus, jobs offering general training do have higher rates of real wage growth than jobs offering only specific training, as predicted by theory. We now turn to the related issue of whether the real wage growth that occurs in jobs offering considerable general training is as large as is predicted by standard theory? [Table 1 about here]

The percentage increases in productivity during the first two years at the job reported in lines 3 and 4 of Table 1 are quite large. The gain in productivity was 26 to 30 percent during the first three months (between an initial average for the first two weeks and an average for weeks 3 through 13) and another 19 to 25 percent by the end of the second year at the job. The productivity gains were largest in jobs with training that developed skills of some generality. The increase in the worker's reported productivity is clearly considerably greater than the 8 to 12 percent increase in the worker's real wage during the first two years at these jobs. This occurs even at the jobs in which training was reported to be almost entirely general and for which there are many local firms that also need the skills in question.

Lines 5 through 9 of Table 1 report answers to questions about the number of hours devoted to four distinct training activities. During the first three months, training for jobs with the most general training and many local competitors involved an average of 49 hours watching others do the job, 9.6 hours in formal training, 52 hours in informal training by management, and 25.6 hours in informal training by co-workers. The time devoted to training had a value equivalent to 147 hours of an already trained co-worker's time or about 28.3 percent of the output that a co-worker would produce in 3 months. As long as some of the skills taught are general, the required training time seems unrelated to the reported degree of generality. However, jobs reported to teach almost no skills useful in other firms required less training --118 rather than 147 hours in the first 3 months.

Line 10 of the table presents the average costs of training in the first quarter of employment in terms of the opportunity cost of the time of a worker with two years of tenure at the firm, OCEWT. It was calculated by dividing the estimate of total value weighted hours of training (line 9) by 520, the number of hours worked by a fulltime worker in three months. For jobs requiring the most general skills, total training investment was equal in value to 28 percent of the opportunity cost of an experienced worker's time (OCEWT). Line 11 presents estimates of that component of training costs that
is attributable to the time that trainers devoted to training activities during the first quarter. This trainer time is valued at 19 percent of OCEWT. The difference between 28 and 19 percent of OCEWT is the value of the time that new hires spent in formal training and watching others do the job. Line 12 presents the average decrement (relative to a worker with two years of tenure) in reported productivity during the first quarter reported in the same metric (OCEWT) as lines 10 and 11. It was calculated by dividing a weighted average of reported productivity in the first two weeks (wt = .167) and reported productivity in the next 11 weeks (wt = .833) by mean reported productivity of workers with two years of tenure in the job and then subtracting the result from 1 and multiplying by 100. For jobs with the most general skills, the productivity decrement during the first quarter is 26 percent of OCEWT.

Only one more assumption is required to calculate estimates of the rate of growth of productivity net of training costs during the first two years at a firm: the cost of the training that was being provided to workers with two years of tenure on the job. While the 1982 employer survey did not ask questions about the time devoted to training after the first 3 months on the job, a 1983 National Center survey of employers (Hollenbeck and Smith 1984) did ask such questions. This survey found that the proportion of time devoted to full-time training activities during the second year on the job was about one half of the corresponding proportion of the first month. Based on this finding, it was assumed that rates of investment in training decline by one-half between the first three months on a job and the end of the second year.

Lines 13 to 16 of Table 1 present estimates of logarithmic growth of productivity net of training costs between the initial quarter of employment and the end of second year at the firm. Line 13 is the preferred estimate of the growth of productivity net of training costs. It assumes there was no double counting of training costs: i.e. that when the employers told us that new hires 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 hire's time was spent in a training activity which produced virtually no output. Under these assumptions, the calculated logarithmic increase in productivity net of training costs for jobs with the most general training is 51 percent which is 6 times the corresponding increase in real wages [51/8.3].

The estimates reported in lines 14 through 16 of the table make the more conservative assumption that there was double counting—that the lower
productivity reported for new workers reflects in part the portion of their time that was devoted to formal training and watching others do the work. Line 14 was obtained by substituting line 11 for line 10 in the calculation described in the previous paragraph. Under these more conservative assumptions, the logarithmic growth of productivity net of training costs is 44 percent in the jobs requiring the most general training or 5 times the rate of increase of real wages.

The sensitivity of these estimates to changes in assumptions about the scaling of the productivity index can be examined by comparing line 14 to lines 15 and 16. Line 15 of the table presents estimates that are based on the assumption that the reports of productivity differences supplied by our respondents exaggerate true proportionate differences in productivity by a factor of two. This assumption implies that the coefficient of variation of productivity of job incumbents is 6.5 percent, not the 13 percent that our respondents reported it to be and not the 19 percent that studies using hard data on output have found on average. Even under this very extreme assumption, productivity net of training costs for the most general jobs still grows three times faster than the real wage—25.4 percent rather than 8.3 percent. Line 16 of the table presents estimates that are based on the assumption that proportionate differences in true productivity between new and experienced workers are 50 percent greater than those reported (i.e. that the coefficient of variation is 19.5). Under these assumptions, the growth of net productivity in jobs with the most general training is 8 times greater than the growth of wage rates.

Tests of our central hypothesis -- that productivity net of training costs rise more rapidly than compensation during the first 2 years of tenure even in the jobs with the most general training -- are presented in table 2. The null hypothesis actually tested was: Is the ratio of productivity net of training cost in the first 3 months to productivity net of training cost at the end of 2 years, $NP_{Q1}/NP_{2yr}$, equal to or greater than the ratio of hourly compensation at these 2 points in time, $RC_{Q1}/RC_{2yr}$? The hypothesis was tested under different maintained assumptions about double counting and the scaling of relative productivity. The estimate of the ratio of real compensation at the start to real compensation after two years was the inverse of the $\exp(.083)$ (from line 2 of Table 1) adjusted for differences between the growth rates of wages and compensation.

The first column of table 2 reports hypothesis tests that are conditional on the maintained assumption that compensation grows 1 percent less than wages
during the first two years (possibly because the value of medical benefits does not increase in the second year of employment). The second column of the table reports hypothesis tests under a maintained assumption that compensation rises 4 percent faster than wage rates during the first 2 years on a job (possibly because new employees are not eligible for paid vacation or sick leave until they have been at the firm for a whole year)\textsuperscript{14}. An offer of two weeks of paid vacation raises the effective wage by four percent, so a firm which offers 2 weeks of paid vacation to employees with 2 years of tenure but none to new hires effectively raises the growth of compensation 4 percent above the growth of wages. This is not very common so it would appear that 4 percent is an upper bound on the differential between the growth of compensation and wages during the first two years on a job.

[Table 2 about here]

The $t$-statistics reported in the table imply a decisive rejection of the hypothesis that in jobs involving training in skills almost all of which are reported to be useful at other firms that compensation rises at a rate that is greater than or equal to the rise in productivity net of training costs. This is a robust finding. Even when all of the maintained assumptions are selected to favor the hypothesis—compensation increases 4 percent faster than wage rates in the first two years on the job, conservative assumptions are made regarding double counting, and the true increase in relative productivity with tenure is only half of the amount reported by our respondents—, the hypothesis is rejected by a wide margin.

Clearly, during the first year or so on a job, wages grow much more slowly than productivity net of training costs even in the jobs where most of the skills being developed by training are useful at other firms. Some of the gap between the growth of productivity net of training costs and wages is a consequence of specific training. Even when skills developed by training are all useful in other firms, the package of skills is nevertheless more valuable at the training firm than at other firms. This is because each firm requires a different mix 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. In other cases, later employers may not be aware of the skills that were developed and consequently not assign the worker to a job that makes use of them. The result is that the best fit between a worker’s skills and his/her job is generally at the firm that did the training.
Because of the difficulty of signaling one's general skills to potential employers, there is no guarantee that new hires with better than average skills will be offered comparably higher entry wages even when these skills help them do the job better. These phenomena have the effect of transforming training which the employer honestly believes develops skills that are useful at other firms into training which is in part effectively specific to the firm. To the extent training is effectively specific, wages will rise more slowly than productivity net of training cost.

But the discrepancies between wage and productivity growth are too large to be explained by specific training alone. Using conservative assumptions regarding double counting, the increase in productivity net of training costs was calculated to be 43.9 percent. Given this increase in the worker's net productivity, Table 3 presents estimates of the wage increase that is implied by a standard Becker model of OJT in which training is partially specific and the costs and benefits of specific training are shared. The only set of assumptions that can produce the observed 8.3 percent wage increase is that 90 percent of the training was specific and that 90 percent of the costs of specific training were financed by the employer. The upper bound on the discrepancy between growth rates of compensation and wage rates was 4 percent, so the upper bound on the increase in compensation during the first two years of tenure is 12.2 percent. For the standard model to generate a 12.2 percent increase in compensation, it must be assumed either that 90 percent of training is specific and employers pay 80 percent of its costs or that 80 percent of training is specific and employers pay 90 percent of its costs. For training which was reported to be developing skills almost all of which were useful at other firms, these assumptions seem implausible. If so, the slow growth of wages in the first two years must have another contributing cause such as quasi-rents arising from transition costs and sorting, differences in marginal tax rates and borrowing rates and institutional barriers to steep wage profiles.

[Table 3 about here]

V. Summary and Conclusions

A number of forces have been identified which make it profitable for employers to front load compensation during the first year or two of tenure: (1) sources of job-worker match specificity unrelated to training such as sorting, costs of finding a new job and the reputational damages of turnover and (2) the progressive nature of personal taxation and high borrowing costs
for workers, and (3) legal and contractual constraints on the starting wage. Analysis of data comparing the growth of compensation to the growth of productivity net of training costs in jobs reported to involve skills that were useful at other firms found that during the first two years of tenure that net productivity grows on average 4 to 5 times faster than compensation. If the focus had been on only the first few months of tenure, the multiple by which the growth of net productivity exceeds wage growth would have been even larger. While the effective specificity of training that is reported to be useful elsewhere accounts for a portion of this difference, it does not account for all of it. Consequently, one or more of the forces listed above must be contributing to the front-loading of compensation during the first year or so on a job. The forces that work in the opposite direction—the need to design wage structures to attract those with low quit probabilities and to have the new hire put up a performance bond so as to reduce shirking—appear to be a good deal weaker at least in the first year of tenure.

With this in mind, it becomes a lot easier to see why so many employers complain that "We pay them [apprentices] far more than they're worth" and that other employers are poaching their trained workers. Becker's model says that this complaint cannot be legitimate if all skills are general. The worker must have paid for the training and the second period wage must equal the worker's productivity so quits do not on average impose costs on the employer. The model just developed implies that the employer is correct in perceiving himself to be suffering a loss when a quit occurs. He is not, however, according to the model presented in section 2 and 3 of the paper, losing investments in general training. He is losing (1) the bond he put up at the beginning of the contract to assure the new hire that the firm loses as well if a dismissal occurs, (2) the quasi-rents generated by the investment in information about the quality of the match and the sorting that results, (3) the consumption loan offered upfront to sweeten the compensation package and (4) the quasi-rents resulting from training and learning-by-doing that is firm specific.

The factors influencing wage profiles in the first year of tenure are probably different from those influencing wage profiles of long tenure workers. We have not formally analyzed models with three or more periods, but it appears that the both the bonding and consumption loan effects would have negligible or only very small effects on wage growth during the second, third, fourth and later periods at a firm. We make this speculation because reputational damages from a dismissal ($F_b$) are not likely, in our opinion, to
increase much with longer tenure and should, in fact, decline in the decade preceding retirement. This suggests a special need for Lazear type shirking penalties for workers in their 50s and 60s. Consumption loan effects are likely to be small because older workers are able to borrow at lower interest rates and are more likely to have savings which yield an even lower interest rate and because wage elasticities of turnover, \( \gamma_s \) and \( \gamma_k \), are not likely to decline much after the first year on the job. Quasi-rents derived from sorting could be expected to increase, but we suspect that after the first year on the job they grow rather slowly. Clearly this is an area where our model could be usefully extended. Other extensions that appear desirable include incorporating pay increases based on performance, defined benefit pensions, and damages to the firm's reputation when a dismissal occurs.

Clearly the determinants of the shape of the tenure-wage profile are many. With so many unobservable factors at work, it is unlikely that data on wages alone can settle issues regarding the relative contributions to productivity growth of general and firm-specific training or the relative importance of human capital and Lazear type bonding contracts. Richer data sets containing information on productivity growth, wage growth, training costs, the specificity of training, monitoring costs and other factors would appear to be necessary before significant progress can be made in explaining the wage profiles of workers in long tenure jobs.
<table>
<thead>
<tr>
<th>TABLE 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRAINING, WAGES, AND PRODUCTIVITY OF TYPICAL NEW EMPLOYEES BY GENERALITY OF SKILLS TAUGHT</td>
</tr>
<tr>
<td>Number of Skills Useful Outside This Company</td>
</tr>
<tr>
<td>Almost All</td>
</tr>
<tr>
<td>Most</td>
</tr>
<tr>
<td>Percentage Wage Increase</td>
</tr>
<tr>
<td>1. 1st Yr {-100*\log[\text{MEAN(RWgQ1/RWgCUR})]}</td>
</tr>
<tr>
<td>2. 2 Yrs {-100*\log[\text{MEAN(RWgQ1/RWg2YR})]}</td>
</tr>
<tr>
<td>Percentage Increase in Productivity</td>
</tr>
<tr>
<td>3. From Week 1-2 to Week 3-13</td>
</tr>
<tr>
<td>4. From 1st Quarter to 2nd Yr.</td>
</tr>
<tr>
<td>Hours Spent in Specific Training Activities in First 3 Months</td>
</tr>
<tr>
<td>5. Watching others do the job</td>
</tr>
<tr>
<td>6. Formal training programs</td>
</tr>
<tr>
<td>7. Informal training by management</td>
</tr>
<tr>
<td>8. Informal training by coworkers</td>
</tr>
<tr>
<td>9. Investment in training time</td>
</tr>
<tr>
<td>10. 1st Q training costs [L9/5.20]</td>
</tr>
<tr>
<td>11. 1st Q trainer costs</td>
</tr>
<tr>
<td>12. 1st Q Productivity Decrement</td>
</tr>
<tr>
<td>Growth of Productivity Net of Training Costs-1st Q to 2nd Yr.</td>
</tr>
<tr>
<td>13. No Double Counting</td>
</tr>
<tr>
<td>Conservative Double Counting Assumptions</td>
</tr>
<tr>
<td>14. Reported Prod. is Proport. to True</td>
</tr>
<tr>
<td>15. True Prod. Gain Half that Reported</td>
</tr>
<tr>
<td>16. True Gain 50% Greater than Reported</td>
</tr>
<tr>
<td>Number of cases</td>
</tr>
</tbody>
</table>

**Note:** Sample is limited to jobs for someone hired between July 1, 1980 and August, 1981 and for which all the necessary questions on wage rates, training time, and productivity were answered. The formulas for calculating lines 3, 4, 9 and 11 through 16 are as follows:

- Line 3 = 100*\log[\text{MEAN(Prod}_{WK3-13})/\text{MEAN(Prod}_{WK1-2})].
- Line 4 = 100*\log[\text{MEAN(Prod}_{2YR})/\text{MEAN(Prod}_{WK3-13})].
- Line 9 = .8*L5 + 1.8*L6 + 1.5*L7 + L8, conceptually but editing causes some changes.
- Line 11 = 100*[(1.5*L7 +L6 + L8)/520].
- Line 12 = 100*(1 - \text{MEAN}[(.833*Prod}_{WK3-13} + .167*Prod}_{WK1-2})/\text{Prod}_{2YR}], conceptually but editing procedures cause some differences.
- Line 13 = -100*\log([(100 - .5*L10 - L12)/100].
- Line 14 = -100*\log([(100 - .5*L11 - L12)/100].
- Line 15 = -100*\log([(100 - .5*L11 - .5*L12)/100].
- Line 16 = -100*\log([(100 - .5*L11 - 1.5*L12)/100].
Table 2

T-TESTS OF THE HYPOTHESIS THAT PRODUCTIVITY NET OF TRAINING COSTS RISES FASTER THAN COMPENSATION

<table>
<thead>
<tr>
<th>Measurement Assumptions</th>
<th>1 % less than wages</th>
<th>4 % more than wages</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Double Counting</td>
<td>18.5</td>
<td>15.2</td>
</tr>
<tr>
<td>Conservative Double Counting Assumptions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reported Productivity is Proportional to True plus Error</td>
<td>17.6</td>
<td>14.6</td>
</tr>
<tr>
<td>True Gain is Half Reported Gain</td>
<td>12.2</td>
<td>8.6</td>
</tr>
</tbody>
</table>

The tabulations and hypothesis tests were done using end of period levels as the base for defining rates of change. This is necessitated by the fact that productivity net of training costs during the first quarter is zero or negative in some jobs. The null hypothesis was \((NP_{Q1}/NP_{2yr}) - (RC_{Q1}/RC_{2yr}) \geq 0\). Where NP = net productivity and RC = real compensation. The hypothesis tests make the conservative assumption that growth rates of productivity and real compensation are independent. The sample is the same as the one producing Column 1 of Table 1.
### Table 3

**WAGE INCREASES PREDICTED BY THE STANDARD MODEL OF ON-THE-JOB TRAINING**
(Net Productivity rises 43.9 percent)

**Share of Skills Developed that are Firm Specific**

<table>
<thead>
<tr>
<th>Share of Specific Training Funded by Firms</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>41.2</td>
<td>38.4</td>
<td>35.7</td>
<td>34.0</td>
</tr>
<tr>
<td>50%</td>
<td>38.4</td>
<td>32.9</td>
<td>27.4</td>
<td>24.2</td>
</tr>
<tr>
<td>75%</td>
<td>35.7</td>
<td>27.4</td>
<td>19.2</td>
<td>14.3</td>
</tr>
<tr>
<td>90%</td>
<td>34.0</td>
<td>24.2</td>
<td>14.3</td>
<td>8.3</td>
</tr>
</tbody>
</table>

Note: The standard model's predicted wage increase is equal to $43.9\times[1 - (\text{share skills firm specific})(\text{share funded by firm})]$. 
FOOTNOTES

1. The existence of these transition costs helps explain why so few jobseekers take stopgap jobs while they search for work and why so few new hires continue their search after having accepted a job offer. Search theory attributes this to higher search costs when employed. For some labor markets this explanation rings true, but in so many cases the unemployed worker spends so little time in active search, it is hard to see how having a 40 hour a week job can substantially interfere with search of such low intensity. It is possible, however, for reputational effects to operate in the opposite direction (i.e. for T to be negative). Taking a very prestigious job [e.g. an Assistant Professor at MIT] may so enhance reputation and improve contacts that the distribution of job offers will shift up. Employers whose reputation is such that taking a job there enhances the worker's marketability can achieve target compensation levels, R, at lower cost and will typically find it optimal to backload their compensation package.

2. For most jobs, the firm's expected costs of recruiting and selecting a replacement if there is an unanticipated quit are considerably smaller than a worker's costs of finding another job if terminated involuntarily. When small and medium sized firms hire for a nonsupervisory position, they consider on average only nine applications, interview only five of the applicants and devote a total of only 10 hours of staff time to the task of filling one position. New positions are filled on average of 16 days after beginning the search. In 55 percent of the cases the firm had advance notice of the opening and so the job was not uncovered during much of the search.

3. The sorting effect may be thought of as the return to investment in information about the quality of the match. The firm learns about the trainability and productivity of the employee and the worker learns about conditions of work, the friendliness of coworkers and the quality of supervision and training and about his/her talent and taste for the work. After this information generates some separations, the employer and remaining workers receive a return on their investment in match specific knowledge.

4. Assuming a yearly $a = .75$, unemployment spells of one-third of a year and a UI replacement rate of .4, the ratio of the search costs resulting from an involuntary termination to the present discounted value of future wage payments is $(1-.4)*.333/[1/(1-.75)] = .05$. The wage reduction that results from an involuntary termination is in part due to the signal that it transmits. It would not be unreasonable for this signaling effect to lower the worker's wage in subsequent jobs by an additional 5 percent.

5. 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 influence the tenure profile of wages and thus induce employers to frontload compensation and thus appear to share the costs of general training. Parsons (1972) points out that "The worker's ...discount rate will affect the firm's choice of wage policies....It can be shown that firms will decrease the worker's share of specific investment as the workers discount the future more heavily (p.1129)."
6. In the adverse selection models of Salop and Salop (1976) and Nickell (1976) workers have information not available to firms on how likely they are to quit, so since turnover is costly, some employers attempt to attract those with low quit probabilities by imposing a hiring fee (through a below market starting wage) and raising the wage level in subsequent periods. The equilibrium wage pattern results in the worker paying all the costs and receiving all the benefits of investments in specific human capital and in wage rates which rise in step with gains in productivity net of training costs.

7. Medoff and Abraham's findings, however, do have alternative explanations. The data available to Medoff and Abraham provided measures of productivity and wage rates. The theories being tested, however, specify a relationship between productivity net of training costs and compensation. The least tenured workers in a particular employment grade are likely to be those who have been recently promoted into the job and/or are likely to be shortly promoted into a higher grade. As a result, they are probably getting more intensive training than the older, more tenured workers in that employment grade. This means that even though productivity may be negatively correlated with tenure within an employment grade, productivity net of training costs (production minus the value of the time that others spend training the individual) may be positively correlated with tenure within employment grade. The other possible hole in the Medoff and Abraham argument is that workers with vested pension rights and many years of tenure may find that the present value of their pension benefits is declining as they postpone retirement. If this were the case, total real compensation of workers who are not being promoted as they approach retirement might be falling. The analysis conducted in this paper explicitly accounts for training costs and possible differences between rates of growth of wages and compensation.

8. The survey was the second wave of a two-wave longitudinal survey of employers located in 28 groups of counties scattered around the country. The sample was drawn from lists of establishments paying unemployment insurance taxes that were stratified by size and industry. Because the original survey was designed to evaluate the labor market effects of welfare reform proposals, both large establishments and establishments in industries with a high proportions of low wage workers were over sampled. The sample under represents workers who are employed at large establishments. The second wave attempted to conduct a telephone interview with all the respondents in the first-wave survey and achieved a 70 percent response rate.

9. Comparably defined nonresponse rates for other questions about the new hire were 8.2 percent for previous relevant experience, 3.2 percent for age, 6.7 for education, 8.6 percent for time spent in informal training by a supervisor, and 5.7 percent for a 3-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 augurs well for the quality of the data that results.

10. Further support for the proposition that the proportionality assumption results in an understatement of percentage increases in productivity with tenure 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 semi-skilled blue collar workers. This estimate of the coefficients of variation is smaller than the estimates of the
coefficients of variation for yearly output derived from analysis of objective ratio scale measures of output. These estimates were .265 for sales clerks, .14 for semi-skilled blue collar workers, .167 for workers in routine clerical jobs, .255 in clerical jobs requiring decision making and .206 in service occupations (Hunter, Schmidt and Judiesch 1988). This means that the estimates of percentage growth rates of productivity during the first year on the job reported in this paper are probably conservative.

11. The opportunity costs of the time of management staff members who provided formal and informal training were assumed to be 1.5 times the opportunity cost of the time of co-workers providing such training. Based on the mean values of the productivity index the trainee's time was valued at 80 percent of the opportunity cost of an experienced coworker's time. When supervisors and coworkers are giving informal training to a new employee, the trainee is almost invariably involved directly 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 1985). Consequently, informal training time is assumed to involve only the investment of the trainer's time. The training time index is equal to 0.8 times the hours spent watching others do the job plus 1.8 times the hours in formal training plus 1.5 times the hours in training by management plus hours in training by co-workers. The cost of the trainer was assumed to be two-thirds of the foregoing productivity, since formal training often involves more than one trainee. Thus, 1.8 = (2/3)1.5 + .8. 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.

12. The question about starting wage rates was worded as follows: "What was ____'s starting hourly rate including commissions and incentive pay?" If this question was not answered, the respondent was asked "What was the usual monthly salary including commissions and incentive pay when he started work?"

13. When the ratio derived from the 1983 survey is multiplied by the 1982 estimate of value of training in the first 3 months, we estimate that workers with 2 years of tenure spend 5.5 percent of their time in formal training or watching others do the work and that the time others spend training him or her has a value of 9.5 percent of his or her productivity. One minus this latter figure is the appropriate correction factor for the denominator when conservative aggregation assumptions are used. For liberal assumptions the appropriate correction factor is one minus the sum of these two figures.

14. If a new hire is not approaching retirement age, the fact that most pensions do not vest until many years of service are accumulated has little impact on the rate of growth of total (including pension savings) compensation during the first two years of employment at the firm. For workers who plan to stay at the firm until retirement, pension accruals are a relatively constant share of earnings. Workers who leave shortly after the pension vests do not get an asset of great value for they will have to wait many decades before benefits are paid and the level of the pension depends upon current earnings not their earnings just before retirement (McDermid, Clark and Allen 1987). Workers who intend to leave before the pension vests have no pension accruals.
Since 69 percent of the new hires in the sample are under 30 and 86 percent under 40, adding pension savings to wages to construct an estimate of full compensation results in only a small (less than .5 percent) increase in the calculated growth of compensation in the first two years.
Bibliography


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.


APPENDIX. DERIVATION

Derivatives of Probabilities

with respect to $w^2$:

$$\frac{\partial \Pr(K)}{\partial w^2} = -\phi_0$$

$$\frac{\partial \Pr(S)}{\partial w^2} = \phi \left(1 - \frac{\phi_0}{\Pr(K)^2} F_b\right) = \phi(1-v)$$

with respect to $g$:

$$\frac{\partial \Pr(K)}{\partial g} = \phi_0$$

$$\frac{\partial \Pr(S)}{\partial g} = \phi \left(-g + \frac{\phi_0}{\Pr(K)^2} F_b\right) = \phi(-g + v)$$

with respect to $h$:

$$\frac{\partial \Pr(K)}{\partial h} = \phi_0$$

$$\frac{\partial \Pr(S)}{\partial h} = \phi \left(\frac{\phi_0}{\Pr(K)^2} F_b\right) = \phi v$$

Derivatives of the Conditional Expectations

$E(\epsilon_0 | K)$

Definition: $E(\epsilon_0 | K) = \int_{-\infty}^{\infty} t \phi_0(t) dt / \Pr(K)$

$$\frac{\partial E(\epsilon_0 | K)}{\partial w^2} = \frac{-\left(w^2 - P - g - h\right) \phi_0}{\Pr(K)} - \int t \phi_0 dt \frac{\partial \Pr(K)}{\partial w^2} = \frac{\phi_0}{\Pr(K)} \left[-\left(w^2 - P - g - h\right) + E(\epsilon_0 | K)\right]$$

$$\frac{\partial E(\epsilon_0 | K)}{\partial \Pr(K)^2} = \frac{\phi_0}{\Pr(K)}$$

$E(\epsilon | S)$

Definition: $E(\epsilon | S) = \int_{-\infty}^{\infty} w^2 - U + T - \frac{1 - \Pr(K)}{\Pr(K)} F_b t \phi(t) dt / \Pr(S)$

$$\frac{\partial E(\epsilon | S)}{\partial w^2} = \left(\frac{w^2 - U + T - (1 - \Pr(K) / \Pr(K) \cdot F_b)}{\Pr(S)}\right) - \int t \phi dt \left(\frac{1}{\Pr(S)^2} \cdot \phi\right)(1-v)$$
Differentiation of (*) \(Pr(S)Pr(K) \cdot G_a\)

\(G_a = P+g+h+\varepsilon_0, K - W^2\)

\[
\frac{\partial q_a}{\partial W^2} = \frac{\partial q_a}{\partial g} = \frac{\partial q_a}{\partial h} = 1 - \frac{\partial}{\partial Pr(K)} \frac{q_a}{Pr(K)}
\]

w.r.t. \(W^2\)

\[
\{\partial Pr(S)/\partial W^2 \cdot Pr(K) + \partial Pr(K)/\partial W^2 \cdot Pr(S)\} q_a + Pr(S)Pr(K) \cdot \frac{\partial q_a}{\partial W^2}
\]

\[= \{\partial Pr(S)/\partial W^2 \cdot Pr(K) - \partial Pr(S)/\partial W^2 \cdot Pr(K)\} q_a + Pr(S)Pr(K) q_a - Pr(S)Pr(K)
\]

w.r.t. \(g\)

\[
\frac{\partial Pr(S)}{\partial g} \cdot Pr(K) \cdot q_a + Pr(S) \cdot Pr(K)
\]

w.r.t. \(h\)

\[
\frac{\partial Pr(S)}{\partial h} \cdot Pr(K) \cdot q_a + Pr(S) \cdot Pr(K)
\]

Differentiation of (**) \(Pr(S)Pr(K) \cdot G_b\)

\(G_b = W^2 - \varepsilon_0, S - (1-Pr(K))/Pr(K) \cdot F_b = q_b - \frac{F_b}{Pr(K)}\)

\[
\frac{\partial q_b}{\partial W^2} = 1 - \frac{\partial q_b}{\partial g} = (1-v)(1 - \frac{\partial q_b}{\partial Pr(S)})
\]

\[
\frac{\partial q_b}{\partial g} = \frac{-ug}{\partial Pr(S)} - \frac{ug}{\partial Pr(S)} q_b(ug + v) + v = (ug + v)(1 - \frac{\partial q_b}{\partial Pr(S)})
\]

w.r.t. \(W^2\)
\[
\frac{\partial \text{Pr}(S)}{\partial \omega^2} \cdot \text{Pr}(K) + \frac{\partial \text{Pr}(K)}{\partial \omega^2} \cdot \text{Pr}(S) \cdot \frac{\partial Q^*_b}{\partial \text{Pr}(S)} + \text{Pr}(S) \text{Pr}(K) \cdot (1-v)(1 - \frac{\text{Pr}(S)}{\text{Pr}(K)})
\]

\[
= \{ (1-v) \cdot \text{Pr}(K) + \frac{\partial \text{Pr}(K)}{\partial \omega^2} \cdot \text{Pr}(S) \} \cdot \frac{\partial Q^*_b}{\partial \text{Pr}(S)} + \text{Pr}(S) \text{Pr}(K) \cdot (1-v)(1 - \frac{\text{Pr}(S)}{\text{Pr}(K)})
\]

\[
= \frac{\partial \text{Pr}(K)}{\partial \omega^2} \cdot \text{Pr}(S) \cdot \frac{\partial Q^*_b}{\partial \text{Pr}(S)} + \text{Pr}(S) \text{Pr}(K) \cdot (1-v)
\]

\[
= -\frac{\partial}{\partial \text{Pr}(S)} \left( \frac{Q^*_b}{\text{Pr}(S)} - \frac{1}{\text{Pr}(K)} \right) + \text{Pr}(S) \text{Pr}(K) - \text{Pr}(S) \text{Pr}(K) v
\]

\[
= \text{Pr}(S) \text{Pr}(K) - \frac{\partial}{\partial \text{Pr}(S)} \text{Pr}(S) Q^*_b
\]

w.r.t. \( g \)

\[
\frac{\partial}{\partial \text{Pr}(S)} \text{Pr}(S) Q^*_b - \text{Pr}(S) \text{Pr}(K) U_g
\]

w.r.t. \( h \)

\[
\frac{\partial}{\partial \text{Pr}(S)} \text{Pr}(S) Q^*_b
\]

Since the objective function and constraint are given by

Max \( P - C(g,h) - W^1 + \delta_a [\text{Pr}(K) \text{Pr}(S) Q_a] \)

(*)

s.t \( R \leq W^1 + \delta_b [\text{Pr}(S) \text{Pr}(K) Q^*_b + U-T] \),

(**)

we can obtain (5'), (6'), and (7') by substituting the above results.

**Derivation of (13')**

Denote \( K = \text{Pr}(K), S = \text{Pr}(S), K' = \frac{\partial \text{Pr}(K)}{\partial \omega^2}, S' = \frac{\partial \text{Pr}(S)}{\partial \omega^2} \). The foc for \( W^2 \) is written as

\[
\delta_a [S' \cdot K \cdot Q_a - S \cdot K] + \delta_b [S \cdot K + K' \cdot S \cdot Q_b] = 0
\]

\[
Q_a = P+g+h+E(0\mid K)-W^2 = X_1-W^2, \quad X_1 = P+g+h+E(0\mid K)
\]

\[
Q^*_b = W^2-P-g+T-E(0\mid S)+F_b = W^2 + X_2, \quad X_2 = P+g-T+E(0\mid S)-F_b
\]

Define \( \hat{S} = S' / S (>0) \) and \( \hat{K} = K' / K (<0) \), and dividing through by \( S \cdot K \) the foc is rewritten as

\[
\delta_a [\hat{S} \cdot (X_1-W^2) - 1] + \delta_b [1 + \hat{K}(W^2+X_2)] = 0
\]
\[ W^2(\delta_a S - \delta_b K) = \delta_a \hat{S} \cdot X_1 - \delta_a + \delta_b + \delta_b K \cdot X_2 \]

\[ W^2 = X_1 - \theta(X_1 - X_2) - \frac{\delta_a - \delta_b}{\delta_a S - \delta_b K}, \]

where \( \theta = \frac{-\delta_b K}{\delta_a S - \delta_b K} = \frac{\delta_b \gamma_K}{\delta_a \gamma_S + \delta_b \gamma_K} \), and

\[ \gamma_K = -K \cdot W^2, \quad \gamma_S = \hat{S} \cdot W^2 \] (elasticities)

Also, using elasticities

\[ \frac{\delta_a - \delta_b}{\delta_a S - \delta_b K} = \frac{\delta_a - \delta_b}{\delta_a \gamma_S + \delta_b \gamma_K} W^2, \]

\[ X_1 - X_2 = (g \hat{g}) + h + E(\epsilon_0 | K) + T - E(\epsilon | S) + F_b \]

Thus

\[ (13') W^2 = P + g + h + E(\epsilon_0 | K) - \theta[(g \hat{g}) + h + E(\epsilon_0 | K) + T - E(\epsilon | S) + F_b] - \frac{\delta_a - \delta_b}{\delta_a \gamma_S + \delta_b \gamma_K} W^2 \]

Derivation of (14') and (15')

The foc for \( g \) and \( W^2 \) are

(5') \( C_g = \delta_a \gamma(1 - \beta) K \cdot \chi_a + S \cdot K + \delta_b [S \cdot K - \gamma_0 \cdot S \cdot \chi_b] \),

(5') \( 0 = \delta_a \gamma - (1 - \beta) K \cdot \chi_a - S \cdot K + \delta_b [S \cdot K - \gamma_0 \cdot S \cdot \chi_b] \).

Adding RHS of (5') to (6') we obtain (14')

(14') \( C_g = \delta_a \gamma (1 - \beta) K \cdot \chi_a + \delta_b [(1 - S K) \beta + S K] \).

An alternative expression is obtained by removing \( \chi_a \) from (7'). (This corresponds to old (14')). Multiply \( (v - \beta)/(1 - v) \) to (5') and subtract the result from (6').

(14'') \( C_g = \delta_a S \cdot K \cdot \frac{1 - \beta}{1 - v} + \delta_b \beta + \gamma_0 S \cdot \chi_b \cdot \frac{1 - \beta}{1 - v} - \frac{v(1 - \beta) S K}{1 - v} \).

Also, the expression for \( C_h \) can be modified by substituting the foc for \( W^2 \). Again addition of the RHS of (5') to the foc for \( h \) (6'):

(6') \( C_h = \delta_a [S \cdot K + \gamma \cdot v \cdot K \cdot \chi_a] + \delta_b \gamma_0 S \cdot \chi_b \),
(5') \[ 0 = \delta_a \left[ \phi \cdot (1-v) \cdot K \cdot Q_a - S \cdot K \right] + \delta_b \left[ S \cdot K - \phi_0 \cdot S \cdot Q_b \right] \]
yields,

(15') \[ C_h = \delta_a \phi \cdot K \cdot Q_a + \delta_b S \cdot K, \]

or removal of \( Q_a \) yields

(15'') \[ C_h = \delta_a S \cdot K \left( \frac{1}{1-v} \right) + \delta_b \left[ -S \cdot K \left( \frac{1}{1-v} \right) + \phi_0 S \cdot Q_b \left( \frac{1}{1-v} \right) \right] \]
\[
= \frac{\rho_0}{I-v} \cdot \Pr(S) \cdot Q_b^* \]
APPENDIX B
203. In the first three months of employment, approximately how many total hours does a typical new employee in NAME'S position spend away from normal work activities filling out forms and being told about the company history, benefits and rules?

   RECORD HOURS
   NONE .................. 97
   DK .................... 98
   NA ..................... 99

206. During the first three months, how many total hours does the average new employee spend in training activities in which he or she is watching other people do the job rather than doing it himself?

   RECORD HOURS
   NONE .................. 997
   DK .................... 998
   NA ..................... 999

207. How many weeks does it take 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 had the necessary school-provided training?

   RECORD WEEKS
   NONE .................. 997
   DK .................... 998
   NA ..................... 999

208. How many of the skills learned by new employees in this job are useful outside of this company? (READ LIST)... Almost all .................. 1
   Most ..................... 2
   Some .................... 3
   Or almost none ........... 4
   DK ...................... 8
   NA ..................... 9

209. Focusing on the skills that are useful outside your company, how many other companies in the local labor market have jobs that require these skills? Would you guess (READ LIST)... less than 5 ................. 1
   5 to 15 .................. 2
   16 to 100 ............... 3
   or over 100 ............. 4
   DK ...................... 8
   NA ..................... 9
257A. Was (NAME'S) separation a layoff, a discharge, an induced resignation, or a voluntary resignation?

<table>
<thead>
<tr>
<th>NAME 1:</th>
<th>NAME 2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layoff.</td>
<td>Layoff.</td>
</tr>
<tr>
<td>Discharge</td>
<td>Discharge</td>
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<tr>
<td>Induced</td>
<td>Induced</td>
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<td>Resignation</td>
<td>Resignation</td>
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<tr>
<td>Voluntary</td>
<td>Voluntary</td>
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<td>Resignation</td>
<td>Resignation</td>
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<tr>
<td>Other</td>
<td>Other</td>
</tr>
<tr>
<td>DK</td>
<td>DK</td>
</tr>
<tr>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

(PEOPLE ARE "INDUCED TO RESIGN" PRIMARILY BECAUSE THEY WOULD BE DISCHARGED OR BECAUSE SUPERVISORS HAD EXPRESSED DISSATISFACTION WITH THEIR PERFORMANCE.)

258A. The following questions ask about employee earnings. If possible, please give earnings in hourly terms.

258B. Is (NAME 1's) job paid (READ LIST)

<table>
<thead>
<tr>
<th></th>
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<th>2</th>
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<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
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<tr>
<td>By salary</td>
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<td>100% commission</td>
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<td>Piece rate</td>
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<tr>
<td>Straight time or salary plus tips, incentives and commissions</td>
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<td>(ASK 258C)</td>
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<tr>
<td>DK (GO TO 259)</td>
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<td></td>
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<tr>
<td>NA (GO TO 259)</td>
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</table>

258C. What type of incentive is offered (READ LIST)

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<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commission</td>
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<td>Tips</td>
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<tr>
<td>Group incentives</td>
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<tr>
<td>Individual incentives</td>
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<td>DK</td>
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<td>NA</td>
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</tbody>
</table>

259. What is the average hourly rate paid to workers in (NAME:1's) position who have had 2 years of experience in this job? Please include any commissions, bonuses or incentive pay in your estimate.

$______ ____

DOLLARS CENTS

DK: 9998
NA: 9999
260. What was (NAME'S) starting hourly rate including commissions, and incentive pay?  
<table>
<thead>
<tr>
<th>NAME 1</th>
<th>NAME 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GO TO 263

261. What was (NAME'S) usual monthly salary including commissions and incentive pay when (he/she) started work?  
<table>
<thead>
<tr>
<th>NAME 1</th>
<th>NAME 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GO TO 263

262. How many hours did (NAME) usually work a week?  
<table>
<thead>
<tr>
<th>NAME 1</th>
<th>NAME 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

263. What is NAME'S current hourly wage including commissions and incentive pay?  
<table>
<thead>
<tr>
<th>NAME 1</th>
<th>NAME 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GO TO 265

264. What is (NAME's) current monthly salary, including tips, commissions and incentive pay?  
<table>
<thead>
<tr>
<th>NAME 1</th>
<th>NAME 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GO TO 265

OR, IF (NAME) HAS LEFT COMPANY READ:  
What was NAME'S hourly wage including tips, commissions and incentive pay when he/she left your company. (RECORD RESPONSE, THEN SKIP TO 265.)
263. How many hours does/did (NAME) usually work a week?  

<table>
<thead>
<tr>
<th></th>
<th>NAME 1</th>
<th></th>
<th>NAME 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOURS</td>
<td>DK... 98</td>
<td>HOURS</td>
<td>DK... 98</td>
</tr>
<tr>
<td></td>
<td>NA... 99</td>
<td></td>
<td>NA... 99</td>
</tr>
</tbody>
</table>

266. Has (NAME) received a promotion, or an upgrading of (his/her) job responsibilities since being hired?  

<table>
<thead>
<tr>
<th></th>
<th>NAME 1</th>
<th></th>
<th>NAME 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes (ASK 267).... 1</td>
<td>Yes (ASK 267).... 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No (GO TO 268).... 2</td>
<td>No (GO TO 268).... 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DK (GO TO 268).... 8</td>
<td>DK (GO TO 268).... 8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NA (GO TO 268).... 9</td>
<td>NA (GO TO 268).... 9</td>
<td></td>
</tr>
</tbody>
</table>

267. Approximately how many months after being hired did (he/she) receive the promotion?  

<table>
<thead>
<tr>
<th></th>
<th>NAME 1</th>
<th></th>
<th>NAME 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>RECORD MONTHS</td>
<td>DK... 998</td>
<td>RECORD MONTHS</td>
<td>DK... 998</td>
</tr>
<tr>
<td></td>
<td>NA... 999</td>
<td></td>
<td>NA... 999</td>
</tr>
</tbody>
</table>

268. Have you received or do you expect to receive a tax credit or government reimbursement of part of your training costs for hiring (NAME)?  

<table>
<thead>
<tr>
<th></th>
<th>NAME 1</th>
<th></th>
<th>NAME 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes (GO TO 269).... 1</td>
<td>Yes (GO TO 269).... 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No (GO TO 271A).... 2</td>
<td>No (GO TO 271A).... 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DK (GO TO 271A).... 8</td>
<td>DK (GO TO 271A).... 8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NA (GO TO 271A).... 9</td>
<td>NA (GO TO 271A).... 9</td>
<td></td>
</tr>
</tbody>
</table>

269. Did you know you would be eligible for this at the time you hired (NAME)?  

<table>
<thead>
<tr>
<th></th>
<th>NAME 1</th>
<th></th>
<th>NAME 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes (GO TO 271).... 1</td>
<td>Yes (GO TO 271).... 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No (ASK 270).... 2</td>
<td>No (ASK 270).... 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DK (GO TO 271).... 8</td>
<td>DK (GO TO 271).... 8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NA (GO TO 271).... 9</td>
<td>NA (GO TO 271).... 9</td>
<td></td>
</tr>
</tbody>
</table>
270. When did you learn (NAME) was eligible?

- 19 -

MO... YR
DK............ 999998
NA........... 999999

- 19 -

MO... YR
DK............ 999998
NA........... 999999

271. From which program is the money coming?

TJTC............. 1
WIN Tax Credit... 2
CETA-OJT......... 3
WIN-OJT........... 4
Other Government
Subsidy
SPECIFY......... 5
DK........... 8
NA........... 9

271A. The questions in this section ask about worker training and supervision for NAME's position.

Once we get started if you find it is necessary for me to talk to a supervisor for that position please transfer me to him/her at the end of this interview.

271B. IF YOU MUST SPEAK TO A SUPERVISOR ASK SECTIONS "C" AND "D". ASK FOR SUPERVISOR AT END OF INTERVIEW. ASK 271C - 284.

271C. Is there formal training, such as self-paced learning programs or training done by specially trained personnel, for people hired in NAME's position, or is all the training done as informal on the job training?

Formal training . . . ASK 272 . . . 1
All informal . . . GO TO 273 . . . 2 8
DK . . . . . . ASK 272 . . . . 8
NA . . . . . . ASK 272 . . . . 9
273. IF NOT ALREADY READ, READ:

In the following questions I am going to ask for comparisons among NAMES 1 and 2 and your typical new employee in the same position.

Now switching to informal training during their first 3 months of work, what was the total number of hours management and line supervisors spent away from other activities giving informal individualized training or extra supervision to:

A. Your typical worker in (NAME'S) position.

<table>
<thead>
<tr>
<th>RECORD HOUR</th>
<th>18-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some, DK#</td>
<td>996</td>
</tr>
<tr>
<td>None</td>
<td>997</td>
</tr>
<tr>
<td>DK</td>
<td>998</td>
</tr>
<tr>
<td>NA</td>
<td>999</td>
</tr>
</tbody>
</table>

B. NAME 1 (IF NOT THERE FOR 3 MONTHS ASK: For the period he/she was there how many hours of informal training did he/she receive?)

<table>
<thead>
<tr>
<th>RECORD HOUR</th>
<th>21-23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some, DK#</td>
<td>996</td>
</tr>
<tr>
<td>None</td>
<td>997</td>
</tr>
<tr>
<td>DK</td>
<td>998</td>
</tr>
<tr>
<td>NA</td>
<td>999</td>
</tr>
</tbody>
</table>

C. NAME 2 (IF NOT THERE FOR 3 MONTHS ASK: For the period he/she was there, how many hours of informal training did he/she receive?)

<table>
<thead>
<tr>
<th>RECORD HOUR</th>
<th>24-26</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some, DK#</td>
<td>996</td>
</tr>
<tr>
<td>None</td>
<td>997</td>
</tr>
<tr>
<td>DK</td>
<td>998</td>
</tr>
<tr>
<td>NA</td>
<td>999</td>
</tr>
</tbody>
</table>

INTERVIEWER NOTE: IF RESPONDENT ANSWERS QUESTION 273A, B, or C IN TERMS OF DAYS, WEEKS OR MONTHS READ: You mean NAME received training 8 hours a day for ___ days/weeks/months?

IF 273A, B AND C ARE DK ASK 274. OTHERWISE GO TO 277.
274. How many different management and supervisory level persons give your typical employee in (NAME'S) position informal training?

275. About how many total days of informal training does the typical management level person spend informally training your typical new employee in (NAME'S) position?

276. How many hours each day does the typical management person spend away from performing other duties in order to informally train a typical new employee?
277. During the first 3 months of work what was the total number of hours co-workers who are not supervisors spent away from their normal work giving informal individualized training or extra supervision to:

A. Your typical worker in (NAME'S) position.

<table>
<thead>
<tr>
<th>RECORD HOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some, DK#</td>
</tr>
<tr>
<td>None</td>
</tr>
<tr>
<td>DK</td>
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<tr>
<td>NA</td>
</tr>
</tbody>
</table>

B. NAME 1 (IF NOT THERE FOR 3 MONTHS ASK: For the period he/she was there how many hours of informal training did he/she receive?)

<table>
<thead>
<tr>
<th>RECORD HOURS</th>
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</thead>
<tbody>
<tr>
<td>Some, DK#</td>
</tr>
<tr>
<td>None</td>
</tr>
<tr>
<td>DK</td>
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<tr>
<td>NA</td>
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</tbody>
</table>

C. NAME 2 (IF NOT THERE FOR 3 MONTHS ASK: For the period he/she was there how many hours of informal training did he/she receive?)

<table>
<thead>
<tr>
<th>RECORD HOUR</th>
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</thead>
<tbody>
<tr>
<td>Some, DK#</td>
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<tr>
<td>None</td>
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<tr>
<td>DK</td>
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<tr>
<td>NA</td>
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</tbody>
</table>

INTERVIEWER NOTE: IF RESPONDENT ANSWERS QUESTIONS 277A, B OR C IN TERMS OF DAYS, WEEKS OR MONTHS READ: You mean NAME received training 8 hours a day for ___ days/weeks/months?

(*)

IF 277A, B AND C ARE ALL DK ASK 278. OTHERWISE GO TO 281.
278. How many different co-workers give your typical employee in (NAME'S) position informal training?

279. About how many total days of informal training does the average co-worker spend on training your typical new employees in (NAME'S) position?

280. How many hours each day does the average co-worker spend away from performing other duties in order to informally train a typical new employee?

281. The last set of questions in this section asks about employee productivity.

Please rate your employee on a productivity scale of zero to 100, where 100 equals the maximum productivity rating any of your employees (NAME'S) position can attain and zero is absolutely no productivity by your employee.
282. What productivity score would you give your typical worker who has been in this job for 2 years? (PROBE FOR NUMBER)

283. Now, for each of the following time periods compare the productivity on this same scale of (NAME 1), (NAME 2) and your typical worker in this position. What is the productivity of (NAME/your typical worker) during (READ LIST)...

A. (His/her) first 2 weeks of employment?

   NAME 1  NAME 2  TYPICAL WORKER
   __________  __________  __________
   RECORD #  RECORD #  RECORD #
   NONE..997  NONE..997  NONE..997
   DK..998    DK..998    DK..998
   NA..999    NA..999    NA..999

B. From (his/her) 3rd week to the 12th week at work? (IF NAME 1/NAME 2 LEFT COMPANY BEFORE 12th WEEK – Q. 257 - DO NOT ASK Q. 283C)

   __________  __________  __________  __________  __________  __________
   RECORD #  RECORD #  RECORD #
   DK..998    DK..998    DK..998
   NA..999    NA..999    NA..999

C. (DO NOT ASK FOR TYPICAL WORKER) Today?

   OR, IF NAME NO LONGER WORKS FOR COMPANY READ: The last week NAME worked for your company?

   __________  __________
   RECORD #  RECORD #
   DK..998    DK..998
   NA..999    NA..999

283A. IF TYPICAL WORKER - IS LESS PRODUCTIVE AFTER 2 YEARS (Q. 282 IS LESS THAN Q. 283B, TYPICAL WORKER*) ASK 284. OTHERWISE GO TO 284A.