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Do Some Employers Share the Costs and Benefits of General Training?

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Abstract

[Excerpt] One of the central propositions of the human capital theory of on-the-job training is that workers pay all the costs and receive all the benefits of general training (see Ehrenberg and Smith 1996, Filer, Hammermesh and Rees 1996, Borjas 1996, Kaufman 1986). Since general training raises a worker's ability to be productive in other organizations as well as the one providing the training, the training firm 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. Is this correct? Do "Workers pay all the costs" of training in skills that are technically general (i.e. useful at other firms)--WPAC for short? Do "workers receive all the benefits" of general training ("WRAB" for short)?

Keywords

employee, employer, training, skill, pay, benefit, wage, productivity, work, OJT

Comments

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DO SOME EMPLOYERS SHARE THE COSTS AND BENEFITS OF GENERAL TRAINING?

I. INTRODUCTION

One of the central propositions of the human capital theory of on-the-job training is that workers pay all the costs and receive all the benefits of general training (see Ehrenberg and Smith 1996, Filer, Hammermesh and Rees 1996, Borjas 1996, Kaufman 1986). Since general training raises a worker's ability to be productive in other organizations as well as the one providing the training, the training firm 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. Is this correct? Do "Workers pay all the costs" of training in skills that are technically general (i.e. useful at other firms)--WPAC for short? Do "workers receive all the benefits" of general training ("WRAB" for short)?

The key assumptions that produce the strong WPAC and WRAB predictions are: (a) labor markets are competitive, (b) workers can finance general OJT investments by borrowing at a fixed interest rate and (c) technically general skills can be cheaply signaled to other potential employers.

We argue below that most work environments violate one or more of these assumptions. When more realistic assumptions are substituted, theory's predictions change. A model of OJT that incorporates imperfectly signaled general skills and/or liquidity constraints makes much weaker predictions: "workers pay much of the costs" of technically general training and "receive much of the benefits." These weaker predictions of a more realistic theory of general OJT will be referred to as "WPMC" and "WRMB" respectively.

It is these weaker WPMC and WRMB predictions that have been tested and generally supported by the empirical literature on employer training and wage profiles. The much stronger WPAC and WRAB predictions have, until recently, been impossible to test because data on productivity growth, the cost of employer training and the generality of training have been unavailable (Garen 1988). This paper remedies this gap in the literature by analyzing data sets--the Employment Opportunity Pilot Projects Employer Survey and the National Federation of Independent Business survey-- that have the measures of the generality of training, the costs of training and ratio scale measures of productivity growth necessary to test the WPAC and WRAB hypotheses.

We will begin by defining very explicitly three hypotheses that will be tested in this paper. We define W^1 and W^2 as the wages during (time period 1) and after (time period 2) general training respectively and g as the increase in productivity generated by general training that costs the firm C(g) to provide. Then WPAC implies, *ceteris paribus,* that:

$$\text{HYP 1)} \quad \frac{\partial W^1}{\partial C(g)} = -1$$

In cross section models predicting starting wage rates, *ceteris paribus* means the human capital characteristics of the worker and non-pecuniary attractiveness of the job must be held constant.

WPAC and WRAB also generate a prediction about how changing one's employer affects the derivative of wage growth with respect to training. If training obtained at firm 'k' is either completely general or partially specific, WPAC and WRAB imply:

$$\text{HYP 2)} \quad \frac{\partial (W^{2k}-W^{1k})}{\partial C(g^k)} \geq \frac{\partial (W^{2j\neq k}-W^{1k})}{\partial C(g^k)}$$

Hypothesis 2 says that because training is generally to some degree specific to the firm, its impact on wage growth should be greatest for workers who stay with the firm. If, by contrast, the skills developed are general, but employers are sharing training costs because their liquidity constrained workers are unable or unwilling to finance all training costs (and employers, therefore, lose their investment when turnover occurs), we would expect wage impacts of training to be larger for workers who leave the training firm:

$$\text{NOT HYP 2)} \quad \frac{\partial (W^{2k}--W^{1k})}{\partial C(g^k)} < \frac{\partial (W^{2j\neq k}--W^{1k})}{\partial C(g^k)}$$

In a two period model WPAC and WRAB together imply that productivity growth and wage growth have the following *ceteris paribus* relationship:

$$\text{HYP 3)} \quad \frac{\partial (W^2 - W^1)}{\partial C(g)} -- \frac{\partial (P^2 - P^1)}{\partial C(g)} = \frac{\partial g}{\partial C(g)} + 1 - \frac{\partial g}{\partial C(g)} = 1 > 0$$

Hypothesis 3 says that general training has a larger effect on wage growth than on productivity growth and the gap between wage and productivity growth effects is the reduction in the cost of general training that occurs between periods 1 and 2. This is a difference of differences estimator that should be free of biases from unmeasured ability, unmeasured job characteristics or measurement error in the training variables.

The paper is organized as follows. In Section 2 we expand and generalize Hashimoto's elegant theory of the sharing of the costs and benefits of specific training and show why with our modifications firms choose to offer front loaded compensation packages in which they share the marginal costs of general training with their employees. In this model employers share the marginal costs and benefits of general training because the firm providing general training is better able to assess the success of that training than other employers and this information asymmetry effectively transforms skills that are technically general into skills that are behaviorally specific. In addition employers have better access to capital markets than employees.[1] Liquidity constrained new hires are unable to finance large investments in general training, so employers attract new hires by offering to share some of the costs of increased investments in general training.

It is match specific quasi rents during the second and later years of tenure that cause wage growth to be slower than productivity growth during the initial year on a job. Match specific quasi rents are generated by specific training, but also by sorting, selective turnover and transition costs such as loss of reputation from being dismissed. Consequently, wage profiles during the first year of tenure are subject to so many influences that comparisons of average rates of wage and productivity growth cannot be used to determine whether employers are sharing the costs and benefits of general training (in the sense of hypothesis 1-3). Who pays for general training is best addressed by examining the first derivative of wage and productivity with respect to training.

While some of these results have appeared in earlier papers (e.g. Parsons 1972; Glick and Feuer 1984; Feuer, Glick and Desai 1987), much of the recent training and wage growth literature appears to ignore the effect of difficulties of signaling newly acquired general skills, differential access to capital markets, and large match specific quasi-rents not caused by specific training on wage growth and incentives to invest in training (Garen 1988).

Sections 3, 4 and 5 review the empirical evidence on the three hypotheses.

<u>Section III-- Hypothesis 1--Wages Should be Lower When Training is Underway</u>

(1) Some employers are offering and sometimes indeed requiring that employees take training in skills that are clearly general,

[1] 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 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)."

(2) 'Trainees generally do not have lower wage jobs than equally qualified workers who receive no training,

(3) When new hires for the same job are compared, those who require extra training are paid less but not enough less during the training period to compensate the firm for the additional training costs.

(4) Tracking wage changes reveals no tendency for wage rates to decline when a worker enters an employer sponsored formal training program.

Section IV-- Hypothesis 2--The Impact of Turnover on the Return to Formal Training.

(1) Training has a bigger effect on the wage rates of workers who leave the training firm than on workers who stay.

.Section V-- Hypothesis 3--The Wage and Productivity Impacts of General Training

(1) Contrary to HYP 3, general training has significantly larger effects on productivity growth than wage growth.

The paper concludes with a summary of evidence that some employers share the costs and benefits of general training occurring at their firm. The theory presented in section 2 offers two explanations for this, but others are possible. These other possibilities are also briefly discussed.

II. THEORY

In this section we present a formal exposition of a theory of training and compensation packages that predicts the kinds of empirical findings just reviewed. 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, imperfect signaling of the outcomes of general training and differential access to capital markets are all incorporated into one model. Under certain simplifying assumptions the model generates HYP 1, 2 and 3. However, when more realistic assumptions are made, HYP 1, 2 and 3 are contradicted.

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.

	Worker Productivity	Worker Utility
1st period at the firm	P	W^1
2nd period at the firm	$P+g+h+e_o$	W^2
2nd period at other firms if quit		U(g) - T + e
2nd period at other firms if fired/laid off		U(g) -T $-F_b$ + e

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

e_o 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)+e 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, damaged reputation from having a quit signal on one's resume, lost income while waiting for the next job to start.

F_b is 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+ e. The worker but not his employer learns about a 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, $P+g+h+e_o$. If the worker's productivity is less than the second period wage, the firm will dismiss the worker. The random factor e_o 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 q,, and e. 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 e and e_o are independent is written as:

(1) $$\max_{g,\, h,\, W^1,\, W^2} P - C(g, h) - W^1 + \partial_a.[Pr(S)Pr(K)(P+g+h+E(e_o \mid K) - W^2)]$$

Subject to the constraint

(2) $$R \leq W^1 + \partial_b[Pr(S)Pr(K)W^2 + (1-Pr(S))(U(g)-T+E(e \mid (Q)) + Pr(S)(1-Pr(K))(U(g)-T+E(e \mid S)-F_b)]$$

or $$R \leq W^1 + \partial_b[Pr(S)Pr(K)\{W^2 - U(g) + T - E(e \mid S) - \frac{1-Pr(K)}{Pr(K)}F_b\} + U(g) - T]$$

where

$E(e_o \mid K)$ is the conditional expectation of e_o given that the firm wishes to keep the worker. $E(e_o \mid K) > 0$.

$E(e \mid Q)$ is the conditional expectation of a given that the worker quits the firm. $E(e \mid Q) > 0$.

$E(e \mid S)$ is the conditional expectation of a given the worker wishes to stay in the firm.

$E(e \mid S) < 0.$

∂_a and ∂_b are the 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:

STAY IF $Pr(K)W^2 + (1-Pr(K))(U(g)-T-F_b+e) > U(g) - T + e$

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, (e), 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:

(3) $$Pr(S) = Pr\left(e \leq W^2 - U(g) + T - \frac{1-Pr(K)}{Pr(K)} F_b\right) = \Phi\left(W^2 - U(g) + T - \frac{1-Pr(K)}{Pr(K)} F_b\right)$$

where Φ is the cumulative density function of e.

Note that the argument for the cumulative density function, Φ, contains the term $-\frac{1-Pr(K)}{Pr(K)} F_b$, is minus the odds of being laid off or fired times the additional transition costs, Fb, 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 $P+g+h+e_o$ is less than the second period wage. Consequently, Pr(K) is written as

(4) $Pr(K) = Pr(P+g+h+e_o > W^2) = 1 - \Phi_0(W^2-P-g-h)$

where Φ_0 is the cumulative density function of e_o.

Denoting the probability density function of e and e_o by ϕ and ϕ_0 the first order condition for the second period wage is written as:

(5) $$0 = \delta_a [\partial Pr(S)Pr(K)Q_a - Pr(S)Pr(K)] + \delta_b [Pr(S)Pr(K) - ¢_0 Pr(S)Q_b]$$

where Q_a and Q_b are defined as

$Q_a = P+g+h+E(e_o \mid K)-W^2 > 0,$

$Q_b = W^2 - (U(g) - T - F_b + E(e \mid S)) > 0.$

$$\frac{\partial Pr(S)}{\partial W^2} = \phi(1-v)$$

$$v = \frac{\phi_0 F_b}{Pr(K)^2} = \frac{\gamma_k f_b}{Pr(K)}$$

γ_k = the elasticity of the firm's keep rate, Pr(K), with respect to the 2nd period wage times minus one. $\gamma_k = \phi_0 W^2/ Pr(K) > 0$.

$f_b = F_b/W^2$ 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, $(U(g)-T-F_b+E(e \mid S))$. Note that $\phi_0/Pr(K)^2$ 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, γ_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 are (6) and (7).

(6) $C_h = \delta_a Pr(K)[Pr(S) + (\partial Pr(S)/\partial h)\, Q_{a]} + \delta_b Pr(S)\phi_0 Q_b$

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

(7) $C_g = \delta_a Pr(K)[Pr(S) + (\partial Pr(S)/\partial g)Q_a] + \delta_b\, [1-Pr(K)Pr(S))U_b + \phi_0 Pr(S)Q_b]$

where $C_g = \partial C/\partial g$, $U_g = \partial U/\partial g$, $\partial Pr(S)/\partial g = \phi(-U_g + v)$

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') $C_g = \delta_a Pr(SK)[1 + \gamma_s(U_g + v)\, q_a] + \delta_b[(1-Pr(SK))U_g + Pr(SK)\gamma_{kqb}]$

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

γ_s = the elasticity of the worker's stay rate with respect to the 2nd period wage. $\gamma_s = \phi(1\text{-}v)W^2 / Pr(S) > 0$.

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. In what follows, we examine the economic implications of these conditions.

Signaling General Skills to Other Employers

We will now specify the income opportunity outside the firm, U(g) + e, in more detail. We write U(g) in the following form:

(8) $U(g) = P + \hat{g}$

where P is the productivity of the worker without the general training received in the first period and $\hat{g}$ is the increment to the wage offer due to general training. Employers use the interview and the reputation of the previous employer to predict the true value of the general training. The estimate by other employers of the productivity gain due to the original firm's general training is $\hat{g}$.

Other potential employers cannot observe the exact amount of general human capital that is produced by the training. Katz and Ziderman (1990) provide an excellent discussion of why the worker's next employers may not be able to accurately assess a workers general skills even in the long run. If they can eventually make that assessment the knowledge becomes private information and is not shared with other potential employers. The signal that provides the general labor market information on an individual worker's general skill level contains a good deal of noise. Denoting the signal that other employers receive by g^* , we assume the following relation:

(9) $g^* = g + u$

where a is a noise independent of g.

Given the signal, g^* , other firms predict the true level of general skill. Under the quadratic loss function, the best linear predictor of general skill, $\hat{g}$, is:

(10) $\hat{g} = E(g \mid J) + \beta(g^* - E(g \mid J)) = E(g \mid J) + \beta[g - E(g \mid J)] + \beta u$

where E(g I J) is the conditional mean of general human capital of the particular class of job seekers given information set J. J represents occupation, industry, and firm size of the previous job and background characteristics of the individual. Therefore, U_g is:

(11) $U_g = \beta = \dfrac{var(g \mid J)}{var(g \mid J) + var(u)} < 1,$

where var(g I J) is the conditional variance of g given J (see Leamer pp. 51-55). This implies that a unit increase of technically general skill results in less than proportional increases in other firms' wage offers.

Choosing the Level of Training

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,$\{\delta_a Pr(SK)[1+\gamma^s vq_a]\}$ 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 γ_K, the elasticity of the keep rate with respect to the second period wage. In (6') γ_K is multiplied by q_b, the share of the second period wage that is a quasi rent for the worker.

The first order condition for general training, (7 or 7') characterizes the optimal amount of general training. The marginal cost of general training is equated to the discounted marginal revenue to the firm plus the discounted marginal benefit to the worker. The marginal revenue to the firm from general training has two elements. The first element is the marginal product of a dollar of expenditure on general training for the workers who are going to stay with the firm (Pr(S)Pr(K)). The second element measures the loss the firm is likely to experience because with given W^2, quit rates will rise. The higher level of general skill implies better alternative income opportunities for the worker. For a given second period wage, quits will rise by $\phi(U_g - v)$. Per quit, the loss the firm experiences is $Pr(K)Q_a$-- the probability the firm wants to keep the worker times the quasi rent received by the firm from those workers it keeps.

The marginal benefit of general training to the worker also has two elements. The first element is that, given he or she is leaving the firm, (voluntarily or involuntarily) general training increases the wage offer in other employment. The second element reflects the fact that the increased productivity makes the firm less likely to dismiss the worker. This benefits the worker, and the amount of the benefit is the worker's quasi rent (Q_b) multiplied by the probability that the individual wants to stay, (Pr(S)). The worker benefit of reduced risks of dismissal tends to offset the loss the employer experiences from the quits that are induced by the rise in other firm's wage offers.[2]

Substituting the first order conditions for W^2 and $B = U_g$ and rearranging terms, the condition describing the equilibrium level of general human capital is:

$$C_g = \delta_a Pr(SK)\frac{(1-\beta)}{(1-v)} + \delta_b\beta + \delta_b Pr(SK)\frac{(1-\beta)}{(1-v)}(\gamma_K q_b - v) \qquad (12)$$

Equation (12) implies that investment in general OJT increases with the firm's and the worker's discount factor (δ_a and δ_b) and the retention rate, and decreases if the marginal cost schedule shifts up. The total derivative of q with respect to v is given by:

$$\frac{\partial C_g}{\partial v} = \left\{\delta_a - \delta_b\left[1 - \frac{\gamma_K}{(1-v)}\left(q_b - \frac{f_b}{Pr(K)}\right)\right]\right\}\frac{Pr(SK)\,(1-\beta)\gamma_K}{Pr(K)(1-v)} + [\delta_a + \delta_b(\gamma^K - v)]\frac{(1-\beta)\partial Pr(SK)}{(1-v)\,\partial v} > 0 \qquad (13)$$

Thus an increase in the cost of firing causes increased investment in both general and specific human capital primarily because of its tendency to reduce turnover.

If other firms fully perceive the quality of training provided by the firm ($\beta = 1$), the condition reduces to setting the marginal cost of training (C_g) equal to δ_b, the worker's discount factor. If other firms cannot perceive differentials in training quality ($\beta = 0$), the condition becomes identical to that for specific human capital. The inability of other firms to perceive all of the firm to firm variations in the amount of general human capital has the effect of dividing the marginal returns to general human capital into two parts. The share of the marginal increase in skill that the worker is assured of getting whether or not he/she stays at the firm (β) is discounted by the worker's rate of time preference. The share that is perceived only by the firm that provides the training ($1-\beta$) is depreciated by the retention rate and discounted by the employer's internal rate of return. Improvements in the signals of general training (i.e. an increase in β) will increase investment in general training if and only if:

$$\frac{\partial C_g}{\partial \beta} = \delta_b - \delta_a\frac{Pr(SK)}{(1-v)} - \delta_b\frac{Pr(SK)\gamma_K}{(1-v)}\left(q_b - \frac{f_b}{Pr(K)}\right) + [\delta_a + \delta_b(\gamma_K - v)]\frac{(1-\beta)}{(1-v)}\frac{\partial Pr(SK)}{\partial \beta} > 0 \qquad (14)$$

This expression will tend to be greater than zero when new hires have high turnover rates, the worker's discount factor (δ_b) is not much smaller than the employer's discount factor (δ_a) and an

[2] Studies of quit and layoff rates obtain wage elasticity estimates that range between 2 and .3 (Ehrenberg and Smith 1987; Bishop 1981 Chapter 8). This implies that the elasticities of stay and keep rates are even lower and that $\delta_a\Upsilon_s(-U_g + v)q_a$ and $\delta_b\Upsilon_K q_b$ are small.

increase in the visibility of the training to other employers does not lower the retention rate by very much. On the other hand, if turnover rates are not high, worker discount factors are a small fraction of employer discount factors and retention rates drop significantly when training becomes more visible, the inequality is likely to be reversed and an increase in the quality of the signals of skills learned will decrease investment in general OJT.

Choosing the Wage Structure

Substituting (8) into the first order condition for W^2, rearranging terms and 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:

(15) $$W^2 = [P + h + g + E(e_o \text{ I } K)] - \theta[h + (g\text{-}\hat{}g) + T + F_b + E(e_o \text{ I } K) - E(e \text{ I } S)] - \frac{(\delta_a - \delta_b)\, W^2}{\delta_a\gamma_S + \delta_b\gamma_K}$$

(16) $$W^1 = P - C(g, h) + \delta_a Pr(S)Pr(K)\{\theta[h + g\text{-}\hat{}g + T + F_b + E(e_o \text{ I } K) - E(e \text{ I } S)] + \frac{(\delta_a - \delta_b) W^2}{\delta_a\gamma_S + \delta_b\gamma_K}\}$$

where $\theta = \frac{\delta_b\gamma_K}{\delta_a\gamma_S + \delta_b\gamma_K}$ is the employer's share of the costs of specific human capital investments and of quasi rents

Equation (15) 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, $P+g+h+E(e_o \text{ I } K)$, less the second and third terms in (15). 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, $P+g+h+E(e_o \text{ I } K)$, and the utility of the worker's best alternative job if he/she is laid off or fired, $P+\hat{}g\text{-}T\text{-}F_b + E(e \text{ I } S)$. The second term of 15 and 16 indicates that given the value of θ, the following factors reduce the firm's second period wage offer (and also raise the firm's first period wage offer):

-- Transition costs ($T + F_b$)

-- The difference between a worker's true general human capital, g, and other employer's perception of his general human capital, ^g. (This could be positive or negative depending upon whether the firm provides more or less general training than is average for that occupation and industry) and

-- The average unattractiveness of alternative employment for workers who want to stay, (-E(e I S)).

Costly investments in firm specific training—e.g. 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. As a result, training accelerates wage growth but by less than it accelerates the growth of productivity net of training costs.

Costless increases in second period firm specific productivity tend to raise wage rates in both periods. Examples include:

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

-- The firm's expected gain from having the option of dismissing less productive workers, ($E(e_o$ I 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: $\delta_a Pr(K)\theta > 1\theta$

Also, other things being equal, the firm's second period wage offer declines if θ, the employer's share of quasi rents, increases. Factors that makes θ larger are:

-- The wage elasticity of the keep rate increases relative to the elasticity of the worker's willingness to stay at the firm. (i.e. γ_K is large relative to γ_s). This could be caused by ¢ 0 being large relative to ϕ or by v being close to 1.

-- The worker's valuation of future earnings grows relative to the firm's valuation. (i.e. δ_a/δ_b 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 (15) and (16) 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 (15) and (16) implies that the firm's second period wage will be reduced and the first period wage increased to the extent that:

-- The elasticities of the worker's stay rate, $-\gamma_S$, and of the firm's keep rate, γ_K, with respect to the firm's second period wage are small.

-- The firm's discount factor is large relative to the worker's discount factor, (δ_a-δ_b is large).

Most young workers are liquidity constrained-- that is they are unable to shift as much consumption from the future into the present as they would like because they have neither assets which can be depleted nor access to credit at reasonable terms. In the early 1980s, half of households headed by someone under the age of 25 had less than $746 in financial assets and 19 percent had no financial assets at all. Half of households headed by someone between 25 and 34 had less than $1514 in financial assets and 13 percent had 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.

Studies of the willingness of consumers to substitute consumption over time find that the intertemporal elasticity of substitution is no higher than one and most studies conclude it is .5 or below (Friend and Blume 1975; Hall 1988; Hubbard and Judd 1986). A substitution elasticity of .5 implies that reducing a liquidity constrained worker's wage by one half (in order to pay for general training) roughly quadruples the worker's marginal utility of current consumption. Where significant general training is occurring, the liquidity constraints faced by many workers result in an employment contract in which employer share the costs of general training.

When the worker stays at the firm, the effect of increased general training on wage growth is given by the total derivative:

$$17)\qquad \frac{\partial(W^{2K}-W^{1K})}{\partial g} = 1 + C_g - [1 + \delta_a \Pr(SK)][\theta(1-\beta) + \frac{\partial M}{\partial \delta_b}\frac{\partial \delta_b}{\partial C}\frac{\partial C}{\partial g}] < 1 + C_g$$

When a worker leaves after training, the effect of increased general training is:

$$17')\qquad \frac{\partial(W^{2j\neq K}-W^{1K})}{\partial g} = \beta + C_g - [\delta_a \Pr(SK)][\theta(1-\beta) + \frac{\partial M}{\partial \delta_b}\frac{\partial \delta_b}{\partial C}\frac{\partial C}{\partial g}] < 1 + C_g$$

where M = the second two terms of equation 15 or $\{\theta[Q_a + Q_b] + \frac{(\delta_a-\delta_b)W^2}{\delta_a\gamma_S + \delta_b\gamma_K}\}$

$$\partial M/\partial\delta_b < 0, \qquad \partial\delta_b/\partial C < 0, \qquad \partial C/\partial g > 0$$

General training raises productivity net of training costs by $1 + C_g$. Equation 17 tells us that the wage growth impact of general training is smaller than this for two reasons:

- Technically general skills cannot be accurately signaled, so general training raises wage rates on the external labor market by less than it raises productivity ($\beta < 1$). This means that the training firm does not need to raise the second period wage of trained workers as much as would be required if $\beta = 1$.
- Most young workers are liquidity constrained and are unable or unwilling to finance large investments in general training. The bigger the investment in general training, the bigger the necessary reduction in starting wage rates investments if workers are to pay for it. This causes bb, the worker's valuation of income received in the future, to fall and this shifts the degree of front loading in the optimal employment contract.

A comparison of 17 and 17' leads to the conclusion that wage effects of general training will be larger when the worker leaves the firm, if $\beta = 1$ or is very close to 1.

<u>Summary</u>

a) When employers cannot accurately measure the amount and quality of general OJT that job applicants have received from other employers (B < 1), workers tend to reduce their investment in general OJT and employers pay some of the incremental costs of investment in technically general OJT. Thus an increase in technically general training causes productivity to rise more rapidly than wage rates. The level of investment in general OJT that results and response to improvements in the quality of the signals of general OJT depends on both discount rates, the separation rate, the proportion of marginal investments in general OJT that are perceived by other employers and the response of turnover to marginal increases in the quality of general training that are not accurately perceived by other employers.

b) 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. The young workers who need general training the most would face ruinous increases in their borrowing rates if they tried to borrow to finance large investments in general training. Employers with jobs offering substantial investments in general training compete for these workers by offering a flatter wage profile than is implied by a simple application of general OJT theory.

c) Anything that contributes to the specificity of the match tends to lower the second period wage below worker productivity and raises the first period wage by a compensating amount. Training in firm specific skills is one cause of specificity. Another four are identified: damaged reputation from being fired or quitting, the costs of finding another job, the improvement in the average productivity of the remaining workers that results from dismissing the least productive, and the sorting effect that results from the exit of those with the best alternative opportunities and those who dislike their current job.

d) Consequently, relative rates of growth of wages and productivity in the first year of tenure depend on so many factors, who pays for training (in the sense of HYP 1 and 3) cannot be determined by comparing average rates of wage and productivity growth.

We now turn to empirical evidence testing these predictions.

III. Wages Are Often Not Appreciably Lower during General Training

Many employers violate the prediction that wages must be lowered while general training is underway.

3.1 Employer Sponsored Computer Training at Temporary Help Agencies

Most large organizations offer free training in generic computer applications programs such as MS Word, Word Perfect and Excel. Even temporary help agencies provide such training to their workers. Alan Krueger's (1993) survey of 83 temporary employment agencies found that 59 percent of them provided free up-front computer training for the workers they place. Training costs were shared: the worker committed her time and the agency provided an instructor and training facilities. The agencies were willing to share general training costs because secretaries proficient in word processing generated substantially higher weekly fees when placed and the worker received only half of the increment.

3.2 Employer Sponsored Workplace Literacy Programs

A small but growing number of firms are training their workers in completely general skills such as mathematics, reading, writing, problem solving and interpersonal skills. Based on a telephone survey that achieved a remarkably good 66 percent response rate, Laurie Bassi (1992) has estimated that 10 percent of manufacturing firms with fewer than 500 employees and 8 percent of similarly sized non-manufacturing firms offered such training at the work site and provided at least partial release time for participation. Hollenbeck and Anderson's (1992) survey of Michigan firms with workplace literacy programs also found that most (81 percent) gave their workers released time when they participated in the training. The National Household Education Survey found that less than one percent of all workers had participated in a workplace literacy program in 1991, but those that did spent an average of 80 hours in the program. One-third of participants said it was required by their employer, 54 percent said they were given time off to attend and 49 percent said the costs of the training were paid by their company (Hollenbeck 1993b).

The fact that many companies required worker participation indicates that literacy training is not a new form of untaxed compensation. Indeed one of the reasons why some companies do not offer such training is a concern that workers will feel demeaned by a suggestion that they need to improve their reading and arithmetic skills. To avoid such a reaction, the basic skills training is often integrated with workplace technical training. The word literacy is never used (Mikulecky 1989). Companies with such programs believe the training has raised morale, company loyalty, communication on the job, teamwork, quality of output, productivity and customer satisfaction (Bassi 1992 Table 11A). Clearly, some companies feel strongly enough about the need for their workers to improve these general skills, they were willing to pick up most of the costs of developing skills which are highly useful at other companies and in everyday life.

3.3 Cross-section Studies of Starting Wage Rates

The worker "pays all the costs of general training" hypothesis also fails tests conducted in large representative data sets. Training typically develops both specific and general skills so jobs that offer a lot of training should have lower wages. Most studies, however, fail to confirm this prediction.

In a study of 1979 to 1982 wage rates of recent school leavers in the National Longitudinal Survey, Parson's (1985, table 7.6) found that when "the skills [I am] learning would be valuable in getting a better job," was reported to be "very true", the job paid on average 2.4 to 14 percent more than when the respondent reported the above statement was "not at all true" even when an extensive set of controls for schooling and academic achievement were included in the model.

Lynch's (1992) analysis of 1983 NLSY data found that, controlling on occupation, industry, tenure, experience, schooling and background characteristics, workers who were in the 20th week of an incomplete spell of on-the-job training were paid a significant 5.2 percent extra on average. Patrice Flynn's (1990) analysis of monthly earnings data in the Survey of Income and Program Participation found, that controlling for size of establishment, tenure, experience, schooling, previous training and demographic background (but not occupation), those currently receiving employer provided training earned a statistically significant 5.7 percent less on average. Lillard and Tan's (1986, Table 4.3-4.5) analysis of NLS Young Mens data and Barron, Black and Loewenstein (1989, Table 2) analysis of EOPP data found no significant tendency for wages to be lower while training is underway. Point estimates were negative but so small they might as well be zero from a substantive point of view.

Barron, Berger and Black's (1993a, Table 1) cross section analysis of the SBA financed employer survey found that doubling on-the-job training intensity lowered the starting wage rate by a significant 2 to 4 percent. Doubling the off-site training intensity, however, was associated with a 4 percent higher wage. Even where training is associated with lower wage rates, the magnitude of the effect appears to be much too small to be consistent with standard theory.

Another test of the "employee pays all" hypothesis can be conducted in the 1984 follow up of the High School and Beyond seniors. This survey contains the necessary data on the training received in the current or most recent job and an extensive array of worker characteristics that can be used to control for the skills and ability of the worker. Becker's prediction was tested by regressing the log of the deflated starting wage of the current or most recent job on indicators of the receipt of employer sponsored training while controlling for an array of background characteristics. The coefficients on the training variables and statistics describing the overall fit of the model are presented in Table 1. Contrary to Becker's prediction, the jobs offering some training rather than none or which offer greater amounts of training paid higher starting wage rates even when a whole array of human capital characteristics were controlled. For females the positive effect of receiving training on the starting wage was statistically significant. Adding dummies for occupation and industry did not change the results appreciably.

It can be argued, however, that these findings do not constitute a decisive refutation of the proposition that workers pay all of the costs of general training and share the costs of specific training. Maybe the anomalous findings are caused by unobserved heterogeneity. The argument is that hiring decision makers are better at assessing the ability of job candidates than econometricians with access to NLS or HSB data file and the positive association between wages and training arises because workers who are highly able (in ways not observed by the econometrician) are both paid more and also recruited for jobs that are more complex and that consequently require large amounts of training.

Unobserved heterogeneity no doubt has the effect of contributing to the positive association between training and starting wage rates, but to transform a large negative structural relationship into either zero impacts or statistically significant positive relationships, sorting of more able job applicants into high training jobs would have to be very powerful indeed. If such a selection process were operating, access to training should depend on ability factors that are visible to the analyst as well as on factors that are not visible to the analyst. Yet models predicting training participation shortly after leaving school estimated by Parsons (1985) failed to find large effects of ability proxies such as test scores on the probability of receiving training.

The results of another test of this hypothesis in the High School and Beyond data are presented in Table 2. The dependent variables in the analysis were a dummy variable for having received some employer sponsored training and the trainee's estimate of the total number of hours that were spent in training. The ability proxies hypothesized to have a positive effect on the receipt of training were: test scores, GPA, grades in vocational courses, deportment in school, number of vocational courses, number of academic courses, hours spent doing homework, hours spent working for pay, number of leadership roles, having an internal locus of control (the belief that one controls one's own fate), an index of reading in high school, and a positive response to "do you enjoy working for pay." Variables hypothesized to have a negative effect on the receipt of training were: did not graduate, hours watching TV, and self-reported study habit problems. The model estimated also included controls for tenure on the job and its square, race, hispanic, marital status, 5 variables describing college enrollment since high school, parental education, occupation and income, number of siblings, urban/rural dummies, and a set of ten dummies for region.

Despite reasonably large samples--1938 men and 2554 women--, the analysis offers only limited support for the hypothesized positive association between ability proxies measured in high school and the receipt of training three to four years later. Only two of 18 variables thought to proxy for ability/productivity had significant coefficients of the correct sign in two or more of the 4 regressions: average weekly hours worked for pay during the junior and senior year of high school and the intervening summer and the number of vocational courses taken in the final three years of high school. Of the 72 coefficients tested, only 42 had the hypothesized sign. Of the 11 coefficients significant at the 5 percent level on a two tail test, three had the wrong sign.

Of possibly the greatest significance is the failure of high school grades and test scores to have the expected effect on the receipt of training. Industrial psychologists have found strong positive relationships between success in training and test scores and a somewhat weaker positive relationship between training success and GPA (Hunter, Crossen and Friedman, 1985). Consequently, one would expect employers to seek out such workers for jobs requiring a great deal of training. This does not appear to be the case in this sample for high school GPA had a negative effect on receipt of training in three of the ,four regressions. One coefficient was significantly positive, but there were also two negative coefficients that were also significant (at the 10 percent level on a two tail test). Only one of the eight coefficients on dummies for good grades in vocational subjects was statistically significant. Half of the coefficients on test score were negative.

When filling jobs that require training, employers appear to try to economize on training costs by seeking out workers who have already received some training either on a job or in school. In other respects, however, their selections do not appear to be optimal for they fail to recruit the high school graduates with the strongest academic records and/or with high test scores. Parsons obtained similar results when he estimated models predicting which members of his sample had obtained "high learning" jobs. Given these findings, it is hard to imagine how selection on ability factors that are not proxied by High School and Beyond or NLS variables could be strong enough to transform a large negative effect of training on the starting wage in the true structural model into a positive association in this data set.

Once workers have been out of school for many years, the situation changes. The more able workers have proved themselves to their employers and rewards for cognitive ability-- both higher wages and better training opportunities-- appear to become more substantial. Bartel and Sicherman (1993) and Veum's (1993) analysis of 1986 to 1990 NLSY data found that workers with high 1980 test scores were considerably more likely to receive company training and to be sent to seminars. Unfortunately, these analyses do not control for occupation and industry, so some of the positive relationship uncovered may be due to occupational choice.

3.4 Wages do not Decline When Workers Enter Training

Another way to control for heterogeneity is to follow workers over time and assess whether entering a training program lowers wage growth. Lowenstein and Spletzer's (1994 Table 4) study provides separate estimates of the effect of complete and incomplete training spells on wage growth. They found that those in the midst of incomplete spells of training did not suffer wage declines relative to those who received no training during the previous year. Paul Langermann's (1996a, 1996b) studies of NLSY data also found no statistically significant reductions in wage rates for those receiving training.

3.5 Impact of Training Requirement Differentials on Relative Wage Rates

One possibility is that unobserved heterogeneity problem is really across jobs not across people. Jobs that offer a lot of training might have other undesirable characteristics such as long hours. Assistant professors and Junior Associates at law firms come to mind. Therefore, let us hold the job constant and examine whether workers who require extra training are paid less by an amount equal to the additional training costs they impose on the firm. Workers hired for the same job often have different amounts of relevant work experience and so require different amounts of training. Who pays for the additional costs of training an inexperienced worker? Are workers who require extra training forced to accept much reduced starting wage rates? Or does the employer bear most of the additional costs, hoping to recoup these costs by limiting the wage increase after the completion of training?

Bishop (1987) presents an empirical analysis of EOPP data which addresses this question. He regressed the difference between the starting wage rates of two new hires for the same job on differences in their productivity and training time requirements. Workers who required extra training time were offered lower starting wage rates, but the effect was small. Holding productivity outcomes constant, workers who received 100 extra hours of training during the first 3 months on the job were paid 3.3 percent less both at the start and after one year or so on the job. Barron, Berger and Black (1993a Table 4) analysis of SBA data obtained similar results. Even though about a third of the new hires received more or less training than was typical for the job, wage rates differed from the typical level only 6 percent of the time.

3.6 Is Most Training Firm Specific?

Another possible explanation of these anomalous findings is that almost all training is specific and employers finance all of its costs. Standard models of the sharing of the costs of specific training do not predict that employers pay all of its costs and some of the revisionist theories [e.g. Salop and Salop's (1976) adverse selection theory] predict that employers pay none of the costs of specific training.[3] There is also direct evidence that most training is general. Employers in the EOPP survey were asked, "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." Only 7.5 percent answered "almost none."

On the other hand, different firms require different mixes of general skills. The training firm concentrates on the skills it needs, some of which may not be valued by alternative employers. A particular employer may expect its employees to use Word Perfect for word processing, Lotus 1-2-3 for spreadsheets and Harvard Graphics for presentations. Other firms in the area may have selected a different mix of software packages for their firm, so while familiarity with each of these packages is a general skill, only a few firms may use the same mix of software applications. Thus, the package of general skills workers develop will generally be more valuable at the training firm than at other firms even when each individual skill is correctly perceived to be useful elsewhere.

The mix problem is certainly part of the explanation of the weak wage response to easily signaled general skills. One should not, however, exaggerate its importance. Lotus 1-2-3 experts can learn Excel very easily. Since the office suite market is now dominated by just two programs, other firms that value one's spreadsheet skills are easy to find.

IV. Impacts of Company Training on Wage Growth when Workers leave the Training Firm

Employers who share the costs of general training because liquidity constrained employees are unable or unwilling to finance general training will naturally expect to share the

[3] 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.

benefits during the post training period. Consequently, the wage increase they offer their trainees should be smaller than is available if the worker takes the new skills to another firm. If, however, trained workers are less productive at other firms because some of their skills are technically or behaviorally ($\beta < 1$) specific to the training firm, the wage effects of training will be larger for those who stay at the firm. Only the training firm is willing to offer a wage premium for skills developed in training that are technically or behaviorally specific to the firm.

Therefore, the impact of turnover on the wage growth effects of training provide evidence on how important the liquidity constraint explanation of employer sharing of general training costs and benefits is relative to the imperfect signaling and skills are specific explanation. Two separate analyses of NLSY data have found evidence that supports the importance of the liquidity constraint motive for sharing training investments. Lowenstein and Spletzer (1994) found that wage effects of training were larger when workers switched employers after training. Paul Lengermann's (1996b) analysis of 1979 to 1993 NLSY data found that company training programs lasting more than 4 weeks had long lasting effects on wage rates that were larger when workers switched employers (12.1 percent after 6 years, F=6.38) than when they stayed at the training firm (4.6 percent after 6 years, F=4.98).

V. Wage and Productivity Impacts of General Training

In this section, we examine how the amount of time devoted to training new hires at a firm influences the rate at which their productivity and wage rates grow.

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 is a good data set for testing hypotheses regarding relative rates of wages and productivity growth.[4] Each employer 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." One-third of the employees selected in this manner were blue collar workers, 18 percent were service workers, 15 percent were sales workers and 23 percent were clerical workers. Eleven percent had fewer than 12 years of schooling, 62 percent had exactly 12 years of schooling and 27 percent had more than 12. Forty-two percent of the respondents managed establishments

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[4] 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.

with fewer than 10 employees and 70 percent of them had fewer than 50 employees. Most of these respondents were responsible for setting the wage rates of their employees and hence were familiar with their job performance record.

The 1982 EOPP employer survey asked the employer (or in larger firms the immediate supervisor) to report on productivity of the typical individual hired in the job after two weeks, during the next 11 weeks and at the end of two years at the firm. The rating was made on a "scale of zero to 100 where 100 equals the maximum productivity rating any of your employees in (NAME'S) position can obtain and zero is absolutely no productivity by your employee." For the full data set at the mean values of these indexes of reported productivity were 51.9 during the first two weeks, 66.6 during the next 11 weeks and 79.4 at the time of the interview (or during the last week for those who left). The questions asking for a rating of the productivity of particular workers had a nonresponse rate of only 4.4 percent. Comparably defined nonresponse rates for other questions were 8.2 percent for previous relevant experience, 3.2 percent for age, 6.7 percent for education, 8.6 percent for time spent in informal training by supervisor, and 5.7 percent for a three-question sequence from which starting wage rate is calculated. The low-nonresponse rate implies that our respondents felt that they were capable of making such judgments and augur well for the quality of the data that results.

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

Further evidence that the proportionality assumption results in an understatement of proportionate productivity differences across people in the same job or with different amounts of 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 blue collar workers. This estimate of the coefficient of variation is smaller than the estimates of the coefficient of variation for yearly output derived from analysis of objective ratio scale measures of output. These estimates were .35 for sales clerks, .144 for semi-skilled blue collar workers, .28 in craft jobs, .164 for workers in routine clerical jobs and .278 in clerical jobs with decision making responsibilities (Hunter, Schmidt and Judiesch 1988). This means that the estimates of the effect of training on productivity growth reported in this paper are probably conservative.

The survey distinguished four types of employer-provided training: (1) formal training (provided by a training professional), (2) time spent watching others do the job, (3) informal on-the-job training by supervisors, and (4) informal on-the-job training by co-workers. An index of training intensity was constructed by first valuing trainer and trainee time relative to that of workers with two years of tenure in that job and then combining the time invested in training activities during the first three months on the job. The employers reported that workers with two years of tenure were about 25 percent more productive than new hires during their first three months on the job.[5] The management staff members who provide formal and informal training were assumed to be paid 1.5 times the wage of coworkers. Formal training involves four kinds of costs: development costs, facility costs, trainer time and trainee time. Sometimes, it is one-on-one and sometimes it is done in groups but since most of the establishments in this study are small, class size was probably small as well. Consequently, it was assumed that when all the costs of formal training other than the trainee's time are lumped together-development costs, training materials costs and the value of the trainer's time-- they are about 25 percent greater than the time costs of the trainee.[6] When supervisors and coworkers are giving informal training to a new employee, the trainee is almost invariably directly involved in a production activity. Employers report that for informal training, the trainees are typically as productive while being trained as they are when working alone (Hollenbeck and Smith 1984). Consequently,

[5] The use of the ratio to estimate the relative productivity implicitly involves an assumption that the productivity reports received from employers are a proportional transformation of true productivity plus a random error. The unknown factor of proportionality can be different for every job, every firm and every respondent but a single respondent is assumed to use the same proportionality factor when answering initial and later productivity. If alternatively it were assumed that experienced workers are 50 percent more productive than new hires in their first three months estimates of training investment would be 7 to 15 percent lower.

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

informal training was assumed to involve only the investment of the trainer's time. Training intensity for the first 3 months expressed in units of the time of trained workers has an arithmetic mean of 149 hours and a geometric mean of 76 hours.

The impact of training on productivity and wage growth of specific recently hired workers and typical new hires was estimated by regressing productivity growth during the first year or so on training intensity during the first three months, the duration of training and a vector of control variables. The specifications were as follows:

(18) $P_{2YR} - P_{2WK} = \underline{BX} + b_1 \mathit{ln}L + b_2 \mathit{ln}T + b_3(\mathit{ln}T)^2 + b_4 S^g \mathit{ln}T + \underline{b_4 S} \mathit{ln}T + u$

(19) $P_{iCUR} - P_{i2WK} = \underline{BX} + \underline{B'Z}_1 + b_1 \mathit{ln}L + b_2 \mathit{ln}T + b_3(\mathit{ln}T)^2 + b_4 S^g \mathit{ln}T + \underline{b_b S} \mathit{ln}T + u$

(20) $W_{iCUR} - W_{i2WK} = \underline{AX} + \underline{A'Z}_1 + \alpha_1 \mathit{ln}L + \alpha_2 \mathit{ln}T + \alpha_3(\mathit{ln}T)^2 + \alpha_4 S^g \mathit{ln}T + \underline{\alpha_5 S} \mathit{ln}T + u$

P_{2YR} = Productivity of the typical worker at the end of 2 years. In the logarithmic models the variable is the logarithm of the productivity rating plus 5. In the linear models the productivity variables are the productivity rating on the 0 to 100 scale divided by 79.4, the mean current productivity rating for the new hires and for typical new hires with 2 years of tenure.

P_{2WK} = Productivity of the typical worker during the first 2 weeks.

W_{iCUR}, W_{i2WK} = Current and Starting wage rates of the "i"th new hire.

$\underline{X}$ = a vector of job and firm characteristics ($\underline{B}$ is a vector of coefficients)

$\underline{Z}_i$ = a vector of human capital characteristics of the "i"th new hire

*In*L = logarithm of the required length of training

T = Training Intensity is a weighted sum of the four different types of training received by typical new hires where the weight reflect the assumed costliness of this form of training.

$T = 1.8 * T^F + 1.5 * T^\delta + T^c + .8 * T^W$

T^F = Hours devoted to formal training during the first 3 months ('00s).

T^δ = Hours spent in informal training b y supervisors during the first 3 months ('00s).

T^c = Hours spent in informal training by coworkers during the first 3 months ('00s).

$T^{'W}$= Hours spent training by watching others do the work during the first 3 months('00s).

$\underline{S}$ = a vector of shares of training that are formal, watching others, and informal OJT by co-workers. The excluded category is informal OJT by managers and supervisors. (e.g. $S^F = 1.8T^F/T$)

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

To test for diminishing returns, both training variables were logged and the square of training intensity was also included in the model. Productivity growth during the first 2 years was defined in 2 different ways. Table 3 presents our results when the dependent variables are logarithms of productivity growth and wage growth. Table 3A presents the results when the productivity growth variable is the change in productivity ratings on a 0-100 scale divided by 79.4 and the wage growth variable is the dollar and cents increase in wage rate divided by $5.96, the mean of the current wage. The models contained controls for the characteristics of the new hire, the occupation, SVP, and GED of the job, percent of craft workers and percent of skilled workers at the firm, the cost of machinery used in the job, unionization, importance of vocational training in selection, percentage of the firm's work force under age 25, and reported difficulty in finding reliable unskilled workers.

The first two columns of Table 3 and 3A present models predicting the log of the ratio of typical productivity at two years of tenure to productivity during the first two weeks on the job for the typical new hire. Columns 3-6 of Table 3 and 3A present results using productivity and wage growth data on a particular new hire rather than a typical new hire. Missing data reduces sample sizes by about 100. R squares of the models are slightly higher, however, because characteristics of the worker and the worker's tenure at the time of the interview are included in the structural model of productivity growth. In order to minimize simultaneity problems, the training variables used in these models were for a typical new hire rather than for that particular new hire. Comparisons of columns 1 and 2 with 3 and 4 reveal that the estimated impacts of training are quite similar for these two specifications.

Interactions between Skill Generality and Training

Theory predicts that the more general the training, the greater will be the share of training costs that is paid by the new employee and the resulting rate of wage growth. The effect of skill generality on the marginal productivity of training is not predictable by a priori reasoning. Turnover causes specific training to lose value more rapidly than general training. Since it has a longer payoff period, general training will be profitable even when its immediate impact on job performance is smaller than specific training's immediate impact. On the other hand, general training is supposed to be financed by workers not firms. Workers cannot borrow at as low interest rates as firms, so workers will require very high payoffs if they are to be induced to make the investment. This has the opposite implication. The inability of workers to finance general training may reduce such investment and drive up marginal payoffs to such investment.

The relative importance of these two effects can be tested by interacting training intensity with a measure of the proportion of skills that are general (S^g). The first, third and fifth columns of Table 3 and 3A report results of models of productivity and wage growth that test such an interaction. The coefficients on the training type interactions (vector $\underline{b}_5$) have been constrained to be zero. These models provide evidence on the effect of skill generality on the wage impacts and the marginal product of training. The results suggest that general skills cause the wage effects of training to increase. The interaction coefficient is significant in the linear specification. In the productivity growth models, however, the generality of training has no impact on the marginal productivity of training. The two effects discussed above have offset each other. Apparently, the difficulties workers face in financing general training are as severe a barrier to investment in general training as high separation rates are to investments in specific training.

Comparing Productivity and Wage Impacts of Training

The calculated impact of increases in weighted training intensity from 10 to 100 hours, from 100 to 200 hours and from 200 and 300 hours are tabulated at the bottom of Table 3 and 3A. The first, third and fifth columns are estimates of the impact when training is completely general. In the logarithmic specification, the proportionate productivity increase was .226/.202 for the move from 10 to 100 hours, .134/.115 for increases from 100 to 200 hours and .093/.079 for increases from 200 to 300 hours (double the mean). Wage increases were substantially smaller .0331 for the 10 to 100 hours change and .0146 for the 200 to 300 hours change.

The linear specification generates substantially lower estimates of the impact of training on productivity and slightly lower estimates of the wage response. As before, the wage effects of general training are smaller than productivity effects. The length of training, for example, has highly significant effects on productivity growth but not on wage growth. **Thus both the logarithmic and linear specification produce results that are inconsistent with the proposition that general training has larger effects on wage growth than productivity growth.**

It should also be noted that even in the linear specification, the proportionate increases in productivity generated by an extra 100 hours of training are quite large relative to their cost--about 5 percent of an experienced worker's productivity during a year.[7]

[7] It must be remembered that the productivity payoff to training must include cash flows that compensate for turnover and obsolescence as well the time value of money. Lillard and Tan (1986), for example, have estimated that training depreciates at 15 to 20 percent per year due to obsolescence and turnover. This implies that equilibrium in the training market is likely require that the initial increments in productivity generated by a training program be at least 25 percent of the costs of program.

The Impact of Who does the Training

The second, fourth and sixth columns allow us to test for training type interactions while constraining b_4, the general training interaction, to be zero. The positive and significant coefficient on interactions between intensity of training and the share that is formal training, coworker training or watching others do the work implies that these forms of training have significantly larger effects on productivity growth than OJT by supervisors, the excluded training category. The wage impacts of training are significantly larger for formal training and watching others than for training by managers and coworkers. Formal training is easier to signal to other employers, so the finding of larger wage rate responses to this type of training is easy to understand.

Co-worker training is very effective at increasing productivity, but it has only small effects on wage rates. Apparently, the importance of OJT provided by co-workers is underestimated by all concerned, the employee, the supervisor, and other employers.

Results Using Instrumental Variables in EOPP Data

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

The determinants of training investment were divided into two categories: those that theory predicts directly influence productivity growth and those which influence the cost of training without directly affecting rates of productivity growth conditional on training. The variables in this latter category were the number of alternative employers, dummies for industry, the growth rate of employment, the growth rate of sales, the number of employees at the establishment, the size of firm, the wage rate, a dummy for wage at or below the minimum wage, a dummy for temporary job, dummies for no probationary period, the log of length of the probationary period, dummies for not knowing if there is a probationary period, a measure of the difficulty of firing a worker after the probationary period is ended, a measure of the importance of seniority in determining who is laid off, and characteristics of the local labor market. These variables were used as instruments for the training variables. This involves maintaining the hypothesis that these variables influence the cost of training investments, and therefore, the level and composition of training without influencing the rate at which new employees learn. The X variables assumed to have direct impacts on productivity growth were the variables that were controls in the analysis reported in tables 3 and 3A. They included dummies for occupation, the specific vocational preparation (SVP), and the general educational development (GED) that the Dictionary of Occupational Titles (DOT) specified is necessary for the job, percent of work force skilled, percent of work force who are crafts workers, the importance of vocational education in selection, cost of machinery, unionization, hours worked per week, and characteristics of the hires (i.e., percent under age 25), and an employer response that it is hard to find reliable unskilled workers. When outcomes for particular individuals were being modeled, the new hires' education, sex, relevant prior work experience and tenure were included in the structural model.

This analysis employs a linear specification for both the outcome variables and training intensity:

(21) $P_{iCUR} - P_{i2WK} = \underline{AX} + \underline{A'Z} + a_1 \mathit{ln} L + a_2 T + a_3 T^2 + u$

The results from a variety of specifications are reported in table 4. In the OLS models, the first 100 hours of training raise productivity of typical workers by 10 percent and wage rates by 2.5 percent. For particular new hires, the first 100 hours of training raises productivity 9.3 percent and raises wage rates 2 percent. A doubling of the length of training raises productivity by 1.8 percent and wage rates by .6 percent.

In most cases, estimating by instrumental variables (IV) increases the magnitude of coefficients, but reduces their statistical significance. The IV results also reverse the sign of the coefficient on length of training. The fact that IV estimations increase rather than reduce estimated effects of training intensity suggests that measurement error bias is more serious than simultaneity bias. The IV findings also support the conclusion that training has larger proportionate effects on productivity than on wage rates.

Analysis of NFIB Data

The second data set to be analyzed comes from a survey of a stratified random sample of the 500,000 members of the National Federation of Independent Business (NFIB) conducted during the first half of 1987. Salaried managers in charge of subunits of large publicly owned corporations are not eligible for membership in NFIB, so the sample does not contain data on employment outcomes at large multi-establishment firms. Despite over sampling NFIB members with many employees, most of the firms were very small. The geometric mean for employment was 12.4. A four page questionnaire was mailed to approximately 11,000 firms, and after 3 follow up waves, 2599 responses were obtained. Another 569 firms returned questionnaires saying they did not have any employees.

The questionnaire focussed on the owner's experiences in hiring and training two workers for a particular job. This job was selected by asking: "For which job have you hired the most people over the last two or three years. (If you have more than one job for which you have done a lot of hiring, please select the job requiring the greatest skill.) "**All future questions refer to this job**." After a series of general questions about the character of the job, the owner was asked to select two individuals who had been hired for this job and answer all future questions specifically with reference to those two workers. The selection was made in response to the following question:

> Please think of the last person hired for this job (job X) by your firm prior to August 1986 regardless of whether that person is still employed by your firm. Call this individual person A. The individual hired for job X immediately before person A is called person B. Do not include rehires of former employees.

Owners were asked both about starting wages and initial productivity at the beginning of the second week of employment and about current wage rates and current productivity. If one or both of the new hires had left the firm prior to the date of completing the questionnaire, the owner was asked to provide information on the circumstances which prevailed "at the time of separation." Information of varying degrees of completeness were obtained on 1624 person A's and 1403 person B's. The data on person A and B were stacked producing a sample of 1685 workers with data on productivity and wage growth. Non response to particular questions reduced the sample further to 1242.

The constraints of a mail questionnaire forced a simplification of questions about time devoted to training. Whereas the EOPP questionnaire distinguished formal from informal, and informal training from supervisors from informal training by coworkers, all three of these forms of training were combined in one very short question: "How many hours did you or an employee spend training or closely supervising A or B?" Two other types of training investment were distinguished. The questions were: "How many additional hours (beyond training and close supervision) did A/B spend learning the job by watching others rather than doing it?" and "How many hours did A/B spend reading manuals, etc. in order to learn the job?" Owners were asked to complete this question for the "first week" of employment and for the "next six months."[8] The

[8] Unfortunately, respondents were not told what to do when they felt unable to estimate the time devoted to training. The result was that it was often not clear whether a blank response should be coded as a zero or as a don't know. The following decision rules were adopted. Responses of "Continuous," "DK" and "?" were coded as missing. If the employer had entered a "0" or

logarithm of the total number of hours spent in the three forms of training over the six month period was used as the training variable.

The following models were estimated:

(22) $(P_{iCUR} - P_{i1WK})/ P^{iAvg} = \underline{BX} + \underline{B'Z_I} + b_1 \mathit{ln}T + b_4(1\text{-}S^g)\mathit{ln}T + u$

(23) $(W_{iCUR} - W_{i1WK})/W^{iAvg} = \underline{AX} + \underline{A'Z}_1 + \alpha_1 \mathit{ln}T + \alpha_2(1\text{-}S^g)\mathit{ln}T + u$

(24) $[P_{iCUR} - P_{i1WK}]/P^{iAvg} - [W_{iCUR} - W_{i1WK}]/W^{iAvg} = \underline{CX} + \underline{C'Z}_1 + c_1 \mathit{ln}T + c_2(1\text{-}S^g)\mathit{ln}T + u'$

where

P^{iAvg}, W^{iAvg} = Average for the "i"th worker of initial and current levels of productivity and wages.

The results are presented in Table 5. The $\underline{X}$ vector of firm characteristics includes a set of dummies for occupation, individual incentive pay, group incentive pay, four indicators of skill requirements, cost of the equipment used by the employee, perceived accuracy of performance evaluations, importance of six traits for success on the job. The $\underline{Z}_1$ vector of individual characteristics includes: tenure and its square, gender, race, Hispanic, whether married, schooling, relevant occupational schooling, six dummies for sources of relevant training prior to being hired, age and age squared, relevant experience and its square, and 5 dummy variables describing the recruitment/selection process.

The first column of the table gives the our estimates of the impact of general training on productivity growth, wage growth and the difference between the rates of productivity and wage growth. General training has significant effects on productivity growth. General training also causes productivity to grow at a substantially higher rate than wage rates. The differential is highly significant. The model was also estimated by two-stage least squares.[9] The finding that training affects productivity more than wage rates replicates in the 2SLS analysis.

VI. Summary and Conclusions

Becker's statement that the employee must always pay the full costs of general on--the-job training is apparently not necessarily true. Our analysis of High School Beyond data

"none" for one category of training and left others categories blank, blanks were coded as missing. If the employer had not answered the question about productivity at the end of six months, all training questions about the six months period following the first week were coded as missing. Otherwise, a blank was coded as zero. This procedure probably errs on the side of retaining observations that should have been dropped and this lowers calculated means for the sample. The resulting means for the first week on the job were 18.4 hours for trainer time, 5.7 hours for watching others and 3.5 hours for reading manuals. For the next six months the means were 54.6 hours for trainer time, 20.9 hours for watching others and 12.0 hours for reading manuals.

[9] Besides the personal and firm characteristics listed above that appear in the productivity and wage growth regression, the first stage regression predicting the level of training included: dummies for industry, log establishment size and its square, turnover rate and its square, a dummy indicating the job was a temporary one, the proportion of skills useful at other firms, the number of other local firms that employ workers with the skills learned on this job and 5 indicators of the perceived accuracy of its judgements of worker abilities prior to making hiring decisions.

found that wage rates are not lower in jobs that offer large amounts of employer training. The analyses of EOPP and NFIB employer surveys concluded that general training does not have bigger effects on wage growth than productivity growth as predicted by the simple OJT model. These findings are not inconsistent with theory, only very simplistic theory. We show that when realistic assumptions are made about the imperfect signaling of technically general skills and liquidity constraints faced by young workers (combined with quit and dismissal elasticities that are substantially below infinity), theory's predictions change. Optimal employment contracts often have the employer sharing the costs and benefits of increases in technically general training.

The theoretical analysis presented in section 2 should be seen as an existence proof, not an exhaustive analysis of the reasons why employers and workers choose employment contracts in which employers share the costs and benefits of technically general training in .the sense of HYP 1, 2 and 3. We can think of four other factors that might have similar effects-- wages and Hours regulations, network externalities, and worker risk aversion--, and there are probably others.

Federal regulations require firms to pay their workers while they receive employer sponsored training that increases productivity on their current job (even when the training is voluntary and the skill is useful at other firms) (Bureau of National Affairs, (1993). Consequently, the only way workers can pay for general training (as predicted by theory) is for them to accept a lower wage rate during the training period. This is feasible for entry level training, if the minimum wage constraint is not binding. However, for more senior workers, a wage reduction during voluntary training in new computer applications programs or other general skills would probably be forbidden by federal wage and hours regulations. Wage structures reflect a host of efficiency and equity considerations. Even in non-union settings, changing them is costly-- particularly if compensation is being lowered. Hence when technological change makes a new general skill valuable, the firm must decide whether to provide the training in that skill under the constraint of its predetermined wage structure. By prohibiting the firm from asking workers to take training during uncompensated time, federal wage and hours regulations effectively prevent the firm from inducing its workers to share the costs of training in this general skill.

Network externalities: Many of the skills taught in company training programs are modes of internal communication—e.g. software application programs-- that everyone must adopt if they are to be fully effective. If the firm were to expect workers to pay the full cost of learning such software applications, it would not be able to demand that all workers learn it and the network benefits would not be realized. Consequently, it tries to get as close as possible to 100 percent usage by requiring and paying for training in a skill that is useful at other firms.

Better Informed Employers: Employers are better informed about the likely value of various general skills than workers. Worker uncertainty about whether the particular skill taught at their company is also useful in other jobs may make them unwilling to pay for the training even when the skill is in fact general. Employers will be better informed about the technological uncertainties and, therefore, better able to decide which particular skills should be taught and be more willing to bear the risk of the investment. In many cases, the employer controls how useful general training is on the job over the long term. Having invested in learning a skill at the behest of their employer, workers quite sensibly want to be assured that the company will not shortly be switching to a different E mail system or applications program. Firms assure their workers such switches will be infrequent by offering to pay any training costs that result.

Worker risk aversion results in employment contracts in which compensation does not rise and fall proportionately with actual productivity on-the-job (Stiglitz 1974; Bishop 1987). Firms are held liable when a mistake by an employee damages or kills others. Such implicit contracts weaken worker rewards for better performance and reduce their incentive to improve skills. Employers could reward their workers for developing skills, but this would signal the skill to other firms. A subtler way of inducing training investments is to subsidize it directly and to make it mandatory.

Table 1
The Effect of Receiving Training on a Worker's Starting Wage

	Males		Females		Mean White Males	Mean White Females
Number of different types of training received on the job (range 1-5)	.022 (1.56)	.016 (1.05)	.040* * * (3.40)	.030* * (2.38)	.65	.78
Total Hours of Training (100's)	---	.007 (1.42)	---	.006 (.89)	1.85	.88
Total Hours Training Squared (10,000's)	---	-.00025 * * (2.24)	---	-.00016 (.93)	42.1	11.0
Dummys for Industry & Occupation Included	no	yes	no	yes		
R Square	.065	.131	.078	.121		

The dependent variable is the log of the deflated starting wage of the current or most recent job. The sample is 1980 high school graduates who in 1984 were not attending college full time and do not have a military occupation. The background characteristics that are controlled include: time spent attending college during 1982 and 1983, work experience and vocational training in high school, high school GPA, grades in trade and business courses, test scores, attitudes toward work and school, number of extra curricular activities and leadership positions, self esteem, locus of control, deportment in high school, married, children, number of siblings, race, hispanic, parental income, parental education, parental occupation, urban, rural and 10 regional dummies and length of tenure on job and its square.

Table 2
Effect of Indicators of Learning Ability on Receipt of Employer Sponsored Training

	Mean	S.D.	Received Formal or Informal Training		Hrs of Formal and Informal Training	
			Men	Women	Men	Women
Test Score	52.3	8.8	-.013	.004**	- .7	.82
			(1.19)	(2.32)	(.34)	(.80)
GPA	81.6	7.6	-.004*	-.0026	4.3**	-1.86*
			(1.91)	(1.47)	(2.05)	(1.74)
High Grades-Bus/Clerical	.40	.49	.005	.033	-43.0	-2.0
			(.17)	(1.51)	(1.55)	(.15)
High Grades-Trade & Tech	.18	.38	.012	.014	32.6	53.4**
			(.45)	(.35)	(1.11)	(2.39)
Good Deportment (1-30)	4.2	3.4	-.003	.0007	- .6	-1.3
			(.84)	(.17)	(.15)	(.54)
Vocational Courses	2.3	2.0	.003	.116**	4.3	7.2*
			(.52)	(2.39)	(.67)	(1.82)
Academic Courses	10.1	2.9	-.013***	-.003	-5.2	4.8*
			(2.64)	(.79)	(1.01)	(1.90)
Did Not Graduate	.01	.09	-.10	.12	9.9	155.0*
			(.78)	(.80)	(.71)	(1.8)
Wkly. Hours on Homework	3.3	2.5	-.001	-.0083**	1.96	-.67
			(.20)	(1.96)	(.36)	(.26)
Wkly. Hours in Jobs	16.0	10.1	.003***	.0048***	1.21.4**	
			(2.75)	(4.35)	(.95)	(2.11)
Wkly. Hours Watching TV	20.5	11.7	.000	-.0013	.32	-.006
			(.003)	(1.55)	(.30)	(.01)
# Leadership Roles (1-7)	.70	1.00	-.004	-.007	10.4	8.1
			(.13)	(.24)	(.37)	(.45)
Internal Locus of Control (0-4)	2.72	.66	.02	.005	45.3**	-10.7
			(1.08)	(.27)	(2.27)	(1.03)
Negative Self Esteem (0-4)	.99	.72	-.012	-.029**	-14.3	- .4
			(.73)	(2.12)	(.81)	(.05)
Work Orientation (0-4.9)	3.39	.67	.026	.007	10.9	5.7
			(1.38)	(.48)	(.55)	(.64)
Study Habit Problems (0-4)	1.15	.96	.006	.025**	19.4	1.3
			(.46)	(2.04)	(1.42)	(.18)
Reads a lot (0-3)	1.68	.87	-.004	-.004	-3.5	-1.8
			(.31)	(.34)	(.23)	(.25)
Enjoys working for pay (0-1)	.91	.28	.064	-.054	63.7	-1.5
			(1.64)	(1.45)	(1.54)	(.07)
R^2			.071	.063	.069	.044
Mean of Dependent Variable			.39	.41	133	69
Standard Deviation of Dep. Var.			.49	.49	499	250

The sample was limited to those who reported a wage rate on their current or most recent job. This resulted in 2554 females and 1938 males. The models included controls for region, suburban, rural, age, race, Hispanic, number of siblings, handicapping conditions, religious attendance, parental family income, "parents always knew where I was" scale, enrolled in post secondary education, in the military, length of time at the job, and participation in cooperative vocational education, work study, Talent Search or CETA.

Table 3: Impact of Training on Growth of Productivity and Wage Rates
Logarithmic Model

	Mean	SD	Productivity Typical Worker (2 Yrs.)		Productivity Specific Worker (avg. of 1.2 Yrs)		Wage Rate Specific Worker (avg. of 1.2 Yrs)	
Logarithm of								
Training Length	1.84	1.28	.059***	.057***	.047***	.045***	.0067**	.0065*
			(5.52)	(5.35)	(3.98)	(3.02)	(1.99)	(1.93)
Training Intensity	4.33	1.31	-.123**	-.136**	-.095	-.092	-.0005	.0055
			(2.28)	(2.50)	(1.61)	(1.56)	(.03)	(.31)
Training Intensity^2	20	11	.032***	.031***	.026***	.023***	.00165	.00073
			(4.88)	(4.63)	(3.65)	(3.18)	(.81)	(.35)
Interaction of Log Training Intensity with								
General Skill%	3.29	1.86	.000			.003		.0029
			(.01)			(.35)		(1.05)
Formal OJT%	.29	.86		.040**		.061***		.0139***
				(2.47)		(3.43)		(2.75)
Co-worker OJT%	.74	.91		.031**		.035**		-.0011
				(2.03)		(2.10)		(.24)
Watch Others OJT%	1.12	1.08		.048***		.044***		.0074*
				(3.60)		(3.07)		(1.81)
Tenure								
For Specific Worker	1.16	1.24			.0786**	.0798**	.098***	.098***
					(2.44)	(2.48)	(10.30)	(10.25)
Tenure SQ	2.90	9.04			-.0076*	-.0080*	-.0024*	-.0024*
					(1.70)	(1.79)	(1.73)	(1.72)
Characteristics of Job and Firm			X	X	X	X	X	X
Characteristics of the New Hire					X	X	X	X
Impact of Training Intensity Increase								
From 10 to 100 hours			.226	.181	.202	.154	.0262	.0242
From 100 to 200 hours			.134	.119	.115	.094	.0129	.0088
Free 200 to 300 hours			.093	.083	.079	.065	.0083	.0055
Formal Training from 100 to 200 hours			--	.147	--	.136	--	.0184
Coworker OJT from 100 to 200 hours			--	.130	--	.118	--	.0089
Watching others from 100 to 200 hours			--	.152	--	.124	--	.0136
Standard error of estimate			.596	.594	.626	.623	.178	.178
R^2			.174	.180	.170	.178	.234	.238
Number of Observations			2116	2116	2002	2002	1963	1963

Analysis of EOPP Employer Survey. The job and firm characteristics controlled in all models were dummies for seven occupational categories, sun of the DOT General Education Development ratings, DOT Specific vocational preparation rating, rating of the importance of vocational education, hours worked per week, proportion of workers high skill. proportion of craft workers, cost of capital equipment used in job, indicator of difficulty of finding qualified workers and percentage of employees under the age of 25. When a particular worker's wage and productivity outcomes were the dependent variable, controls were included for the following worker characteristics: years of schooling, relevant vocational schooling dummy, years of relevant work experience and its square, years of non-relevant work experience and its square, female dummy, and tenure and its square. The arithmetic mean of training intensity during the first 3 months was 149 hours. The geometric mean was 76 hours. In the years prior to the survey, inflation ran at a 6 percent annual pace. The wage changes analyzed were not deflated for price inflation, so the coefficient on tenure in the wage growth model reflects price inflation as well as gains in real wages.

Table 3A
Impact of Training on Growth of Productivity and Wage Rates
Linear Model

	Mean	SD	Productivity Typical Worker (2 Yrs.)		Productivity Specific Worker (avg. of 1.2 Yrs)		Wage Rate Specific Worker (avg. of 1.2 Yrs)	
Logarithm of								
Training Length	1.84	1.28	.0264***	.0258***	.0187***	.0182***	.0045	.0040
			(4.98)	(4.89)	(3.26)	(3.18)	(.89)	(.79)
Training Intensity	4.33	1.31	.0139	.0060	.0383	.0418	-.0294	-.0215
			(.52)	(.23)	(1.50)	(1.44)	(1.15)	(.83)
Training Intensity^2	20	11	.0059*	.0600*	.0005	.0000	.0053*	.0042
			(1.83)	(1.85)	(.16)	(.01)	(1.73)	(1.33)
Interaction of Log Training Intensity with								
General Skill%	3.29	1.86	.0007		.0016		.0071*	
			(.16)		(.35)		(1.72)	
Formal OJT%	.29	.86	.0084		.061***		.0203***	
			(1.04)		(3.43)		(2.66)	
Co-worker OJT%	.74	.91	.0166**		.035**		-.0028	
			(2.19)		(2.10)		(.39)	
Watch Others OJT%	1.12	1.08	.0150**		.044***		.0173***	
			(2.29)		(3.07)		(2.79)	
Tenure								
For Specific Worker	1.16	1.24			.0786**	.0781***	.0968***	.0956***
					(2.44)	(4.96)	(6.69)	(6.62)
Tenure SQ	2.90	9.04			-.0076*	-.0080***	-.0045**	-.0044**
					(1.70)	(3.65)	(2.14)	(2.13)
Characteristics of Job and Firm			X	X	X	X	X	X
Characteristics of the New Hire					X	X	X	X
Impact of Training Intensity Increase								
From 10 to 100 hours			.128	.109	.100	.096	.0331	.0175
From 100 to 200 hours			.051	.045	.031	.029	.0210	.0139
From 200 to 300 hours			.032	.029	.018	.017	.0146	.0100
Formal Training from 100 to 200 hours			--	.051	--	.071	--	.0280
Coworker OJT from 100 to 200 hours			--	.057	--	.053	--	.0120
Watching others from 100 to 200 hours			--	.056	--	.059	--	.0259
Standard error of estimate			.293	.292	.305	.305	.269	.268
R^2			.140	.144	.147	.150	.120	.125
Number of Observations			2116	2116	2002	2002	1963	1963

Analysis of EOPP Employer Survey. The job and firm characteristics controlled in all models were dummies for seven occupational categories, sun of the DOT General Education Development ratings, DOT Specific vocational preparation rating, rating of the importance of vocational education, hours worked per week, proportion of workers high skill, proportion of craft workers, cost of capital equipment used in job, indicator of difficulty of finding qualified workers and percentage of employees under the age of 25. When a particular worker's wage and productivity outcomes were the dependent variable, controls were included for the following worker characteristics: years of schooling, relevant vocational schooling dummy, years of relevant work experience and its square, years of non-relevant work experience and its square. female dummy, and tenure and its square. The arithmetic mean of training intensity during the first 3 months was 149 hours. The geometric mean was 76 hours. In the years prior to the survey, inflation ran at a 6 percent annual pace. The wage changes analyzed were not deflated for price inflation, so the coefficient on tenure in the wage growth model reflects price inflation as well as gains in real wages.

Table 4

Comparison of OLS & Instrumental Variable Estimates

of the Impact of Training

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

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

Table 5

Impact of General Training

on the Growth of Productivity and Wage Rates

in NFIB Data

	Log Training Hours during First 6 Mo.	Log Training Hrs X Specific Share	R Square	RMSE	Number of Observations
Growth of Productivity					
OLS	.0265*** (8.34)	-.0012 (.36)	.1883	.1175	1242
2SLS	.0328** (2.32)	-.0001 (.04)	.1438	.1183	1182
Wage Rates					
OLS	.0011 (.94)	.0035*** (2.78)	.2369	.0450	1242
2SLS	.0058 (1.06)	.0037*** (2.60)	.2290	.0455	1182
Profits					
OLS	.0254*** (7.80)	-.0047 (1.40)	.1637	.1201	1242
2SLS	.0270* (1.87)	-.0038 (1.02)	.1286	.1209	1182

Analysis of a 1984 survey of members of the National Federation of Independent Business.

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HIGH SCHOOL AND BEYOND--Training Questions

At any time between leaving high school and the end of February 1984, have you held a full-time job? (MARK ONE)

- Yes (ANSWER A)
- No (SKIP TO Q.52)

A. Considering the *most recent* full-time job you have held, which type(s) of employer-provided training benefit(s) or training program(s) did you receive or participate in?
(MARK ALL THAT APPLY. FOR ANY PROGRAMS OR BENEFITS MARKED: ANSWER B AND C, THEN ANSWER D.)

Training Programs or Benefits	B. Number of Hours Per Week	C. Total Number of Weeks
Employer-provided job training during working hours on employer premises		
Informal on-the-job training (e.g., assigned to work with someone for instruction or guidance, etc.)		
Employer-provided education or training provided during working hours away from employer premises		
Tuition aid and/or financial assistance for attending educational institutions after working hours		
Other (SPECIFY)__________		
NONE OF THE ABOVE (SKIP TO Q.52)		

D. Was your participation in some or all of this training *required* by your employer? (MARK ONE)

- Yes, all required
- Yes, some required
- No, none required

NFIB ANALYSIS--ORDINARY LEAST SQUARES

X SECTION OF INDIV--5 reference var--SUBST HIRYY FORTENYY 16:02 Friday, October 11, 1996 16
TR=0 WHEN LEAVE EARLY -ImP vars edited--FORON MISSING EDIT
Dependent Variable: PGRCR2YY
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	55	4.72986	0.08600	6.233	0.0001
Error	1186	16.36261	0.01380		
C Total	1241	21.09248			

Root MSE	0.11746	R-square	0.2242
Dep Mean	0.12415	Adj R-sq	0.1883
C.V.	94.61036		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > ITI
INTERCEP	1	-0.098062	0.06688823	-1.466	0.1429
TENYY	1	0.017461	0.00683737	2.554	0.0108
TENSQYY	1	-0.001958	0.00091070	-2.150	0.0318
LTTYY	1	0.026525	0.00318023	8.341	0.0001
SPLTTYY	1	-0.001196	0.00328345	-0.364	0.7157
YROCCYY	1	-0.003620	0.00388585	-0.932	0.3517
SCHYY	1	0.007536	0.00228487	3.298	0.0010
EXPYY	1	-0.008909	0.00207709	-4.289	0.0001
EXPYYSQ	1	0.000254	0.00008867	2.859	0.0043
AGEYY	1	0.000689	0.00113404	0.608	0.5435
AGESQYY	1	0.000004158	0.00002939	0.141	0.8875
BLKYY	1	-0.004152	0.01736639	-0.239	0.8111
HISPYY	1	-0.008474	0.01792729	-0.473	0.6365
FEMYY	1	0.003310	0.01150415	0.288	0.7736
MARYY	1	-0.010494	0.01129739	-0.929	0.3531
NEWPAPYY	1	-0.002132	0.00876288	-0.243	0.8078
RSUPYY	1	-0.009592	0.00743162	-1.291	0.1971
PERSOFYY	1	-0.025523	0.01762298	-1.448	0.1478
IGPYY	1	-0.006934	0.00764602	-0.907	0.3647
RPREVYY	1	-0.002168	0.00807748	-0.268	0.7885
HUSBYY	1	0.016355	0.01397022	1.171	0.2419
TONYY	1	-0.002411	0.00810507	-0.297	0.7662
TOFYY	1	0.012755	0.01406706	0.907	0.3647
TRPUBYY	1	-0.006966	0.01069841	-0.651	0.5151
TRPRIYY	1	-0.019633	0.01187893	-1.653	0.0986
TRMILYY	1	-0.032907	0.01791992	-1.836	0.0666
TRJTPAYY	1	-0.047335	0.02547844	-1.858	0.0634
IMPOCCB	1	0.001594	0.00247547	0.644	0.5196
IMPLRNB	1	0.001594	0.00306436	0.520	0.6030
IMPHABB	1	-0.003633	0.00376144	-0.966	0.3343
IMPLEADB	1	0.000552	0.00374851	0.147	0.8830
IMPREADB	1	-0.005583	0.00270205	-2.066	0.0390
CRAFT	1	-0.007999	0.02766010	-0.289	0.7725
CONST	1	-0.023611	0.02824474	-0.836	0.4034
SREP	1	0.018541	0.02851125	0.650	0.5156
RETAIL	1	-0.017458	0.02865919	-0.609	0.5425
SERV	1	-0.001820	0.02985327	-0.061	0.9514
LAB	1	-0.035900	0.02960865	-1.212	0.2256
MANAG	1	-0.018574	0.04375113	-0.425	0.6713
CLERK	1	0.004491	0.02891837	0.155	0.8766
SEC	1	0.063210	0.02993363	2.112	0.0349
TECH	1	0.029504	0.02831430	1.042	0.2976
PROF	1	-0.004128	0.03027544	-0.136	0.8916
OPER	1	0.002338	0.03024866	0.077	0.9384
TOPER	1	-0.000334	0.03370016	-0.010	0.9921
OTHER	1	0.017776	0.02937048	0.605	0.5451
GRTHEMP	1	0.007914	0.00750408	1.055	0.2918
PIECE	1	-0.009397	0.00940183	-1.000	0.3177
GROUPI	1	0.011086	0.00999102	1.110	0.2674
VALUELN	1	0.001805	0.00251044	0.719	0.4722
FMATH	1	0.001796	0.00489239	0.367	0.7136
FCOMPUTR	1	-0.001737	0.00250311	-0.694	0.4880
FNEWSKIL	1	0.010786	0.00429682	2.510	0.0122
FCOMM	1	0.002748	0.00441152	0.623	0.5334
FSUPER	1	-0.012132	0.00396872	-3.057	0.0023
ACCUPERF	1	0.001795	0.00315537	0.569	0.5695

Dependent Variable: PGRCR2YY

Test: TRSP	Numerator:	0.5660	DF:	1	F value:	41.0259
	Denominator:	0.013796	DF:	1186	Prob>F:	0.0001
Test: WORK	Numerator:	0.0377	DF:	5	F value:	2.7292
	Denominator:	0.013796	DF:	1186	Prob>F:	0.0185

NFIB ANALYSIS--ORDINARY LEAST SQUARES

X SECTION OF INDIV--5 reference var--SUBST HIRYY FORTENYY 16:02 Friday, October 11, 1996 17
TR=0 WHEN LEAVE EARLY-ImP vars edited--FORON MISSING EDIT
Dependent Variable: GRWAGEYY
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	55	0.89036	0.01619	8.005	0.0001
Error	1186	2.39830	0.00202		
C Total	1241	3.28866			

Root MSE	0.04497	R-square	0.2707
Dep Mean	0.04513	Adj R-sq	0.2369
C.V.	99.64565		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > ITI
INTERCEP	1	0.014029	0.02560795	0.548	0.5839
TENYY	1	0.031226	0.00261767	11.929	0.0001
TENSQYY	1	-0.002378	0.00034866	-6.822	0.0001
LTTYY	1	0.001149	0.00121754	0.944	0.3455
SPLTTYY	1	0.003496	0.00125706	2.781	0.0055
YROCCYY	1	-0.000832	0.00148769	-0.559	0.5763
SCHYY	1	0.000733	0.00087476	0.838	0.4022
EXPYY	1	-0.001202	0.00079521	-1.512	0.1309
EXPYYSQ	1	0.000023675	0.00003395	0.697	0.4857
AGEYY	1	0.000344	0.00043416	0.792	0.4287
AGESQYY	1	-0.000014736	0.00001125	-1.310	0.1906
BLKYY	1	-0.009744	0.00664867	-1.466	0.1430
HISPYY	1	-0.008151	0.00686341	-1.188	0.2352
FEMYY	1	-0.004880	0.00440433	-1.108	0.2681
MARYY	1	-0.002162	0.00432517	-0.500	0.6173
NEWPAPYY	1	0.001559	0.00335484	0.465	0.6421
RSUPYY	1	0.003286	0.00284517	1.155	0.2484
PERSOFYY	1	0.008871	0.00674690	1.315	0.1888
IGPYY	1	0.001322	0.00292725	0.452	0.6515
RPREVYY	1	0.002132	0.00309244	0.690	0.4906
HUSBYY	1	-0.002492	0.00534846	-0.466	0.6413
TONYY	1	-0.005892	0.00310300	-1.899	0.0578
TOFYY	1	0.004317	0.00538553	0.802	0.4230
TRPUBYY	1	0.003360	0.00409585	0.820	0.4122
TRPRIYY	1	0.001799	0.00454781	0.396	0.6925
TRMILYY	1	-0.002531	0.00686059	-0.369	0.7122
TRJTPAYY	1	-0.021469	0.00975434	-2.201	0.0279
IMPOCCB	1	-0.000872	0.00094773	-0.920	0.3575
IMPLRNB	1	0.000324	0.00117318	0.276	0.7827
IMPHABB	1	-0.002167	0.00144006	-1.505	0.1326
IMPLEADB	1	-0.000467	0.00143511	-0.325	0.7451
IMPREADB	1	-0.000074457	0.00103447	-0.072	0.9426
CRAFT	1	-0.033567	0.01058958	-3.170	0.0016
CONST	1	-0.033222	0.01081341	-3.072	0.0022
SREP	1	-0.049678	0.01091545	-4.551	0.0001
RETAIL	1	-0.035581	0.01097208	-3.243	0.0012
SERV	1	-0.044233	0.01142923	-3.870	0.0001
LAB	1	-0.038260	0.01133558	-3.375	0.0008
MANAG	1	-0.072028	0.01674999	-4.300	0.0001
CLERK	1	-0.035493	0.01107131	-3.206	0.0014
SEC	1	-0.044102	0.01146000	-3.848	0.0001
TECH	1	-0.035558	0.01084004	-3.280	0.0011
PROF	1	-0.054141	0.01159086	-4.671	0.0001
OPER	1	-0.045395	0.01158060	-3.920	0.0001
TOPER	1	-0.041096	0.01290200	-3.185	0.0015
OTHER	1	-0.041976	0.01124440	-3.733	0.0002
GRTHEMP	1	0.002643	0.00287291	0.920	0.3577
PIECE	1	0.004559	0.00359946	1.267	0.2056
GROUPI	1	0.004448	0.00382503	1.163	0.2451
VALUELN	1	0.001176	0.00096111	1.223	0.2215
FMATH	1	-0.002122	0.00187304	-1.133	0.2576
FCOMPUTR	1	-0.000917	0.00095831	-0.957	0.3389
FNEWSKIL	1	0.001627	0.00164503	0.989	0.3228
FCOMM	1	0.004093	0.00168894	2.424	0.0155
FSUPER	1	-0.000078227	0.00151941	-0.051	0.9589
ACCUPERF	1	0.000307	0.00120802	0.255	0.7991

Dependent Variable: GRWAGEYY

Test: TRSP	Numerator:	0.0190	DF:	1	F value:	9.4158
	Denominator:	0.002022	DF:	1186	Prob>F:	0.0022

Dependent Variable: GRWAGEYY

Test: WORK	Numerator:	0.0032	DF:	5	F value:	1.5813
	Denominator:	0.002022	DF:	1186	Prob>F:	0.1624

NFIB ANALYSIS--ORDINARY LEAST SQUARES

X SECTION OF INDIV--5 reference var--SUBST HIRYY FORTENYY 16:02 Friday, October 11, 1996 20
TR=0 WHEN LEAVE EARLY-ImP ears edited--FORON MISSING EDIT
Dependent Variable: PROFI2YY
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	55	4.29773	0.07814	5.416	0.0001
Error	1186	17.11174	0.01443		
C Total	1241	21.40946			

Root MSE	0.12012	R-square	0.2007
Dep Mean	0.07902	Adj R-sq	0.1637
C.V.	152.00631		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > ITI
INTERCEP	1	-0.112091	0.06840226	-1.639	0.1015
TENYY	1	-0.013765	0.00699214	-1.969	0.0492
TENSQYY	1	0.000421	0.00093132	0.452	0.6515
LTTYY	1	0.025376	0.00325222	7.803	0.0001
SPLTTYY	1	-0.004693	0.00335777	-1.398	0.1625
YROCCYY	1	-0.002788	0.00397381	-0.702	0.4830
SCHYY	1	0.006803	0.00233659	2.912	0.0037
EXPYY	1	-0.007706	0.00212411	-3.628	0.0003
EXPYYSQ	1	0.000230	0.00009068	2.535	0.0114
AGEYY	1	0.000345	0.00115971	0.298	0.7658
AGESQYY	1	0.000018894	0.00003006	0.629	0.5297
BLKYY	1	0.005592	0.01775948	0.315	0.7529
HISPYY	1	-0.000323	0.01833308	-0.018	0.9860
FEMYY	1	0.008190	0.01176455	0.696	0.4865
MARYY	1	-0.008332	0.01155311	-0.721	0.4709
NEWPAPYY	1	-0.003691	0.00896122	-0.412	0.6805
RSUPYY	1	-0.012878	0.00759983	-1.694	0.0904
PERSOFYY	1	-0.034395	0.01802188	-1.908	0.0566
IGPYY	1	-0.008256	0.00781909	-1.056	0.2912
RPREVYY	1	-0.004300	0.00826032	-0.521	0.6028
HUSBYY	1	0.018848	0.01428644	1.319	0.1873
TONYY	1	0.003481	0.00828852	0.420	0.6745
TOFYY	1	0.008438	0.01438547	0.587	0.5576
TRPUBYY	1	-0.010326	0.01094057	-0.944	0.3454
TRPRIYY	1	-0.021433	0.01214781	-1.764	0.0779
TRMILYY	1	-0.030375	0.01832554	-1.658	0.0977
TRJTPAYY	1	-0.025867	0.02605514	-0.993	0.3210
IMPOCCB	1	0.002467	0.00253151	0.974	0.3300
IMPLRNB	1	0.001271	0.00313372	0.405	0.6852
IMPHABB	1	-0.001466	0.00384658	-0.381	0.7032
IMPLEADB	1	0.001019	0.00383336	0.266	0.7905
IMPREADB	1	-0.005509	0.00276321	-1.994	0.0464
CRAFT	1	0.025568	0.02828619	0.904	0.3662
CONST	1	0.009611	0.02888406	0.333	0.7394
SREP	1	0.068219	0.02915661	2.340	0.0195
RETAIL	1	0.018123	0.02930790	0.618	0.5365
SERV	1	0.042413	0.03052900	1.389	0.1650
LAB	1	0.002361	0.03027885	0.078	0.9379
MANAG	1	0.053454	0.04474144	1.195	0.2324
CLERK	1	0.039984	0.02957294	1.352	0.1766
SEC	1	0.107312	0.03061118	3.506	0.0005
TECH	1	0.065061	0.02895519	2.247	0.0248
PROF	1	0.050013	0.03096073	1.615	0.1065
OPER	1	0.047733	0.03093334	1.543	0.1231
TOPER	1	0.040762	0.03446296	1.183	0.2371
OTHER	1	0.059752	0.03003529	1.989	0.0469
GRTHEMP	1	0.005270	0.00767394	0.687	0.4924
PIECE	1	-0.013956	0.00961465	-1.452	0.1469
GROUPI	1	0.006637	0.01021716	0.650	0.5161
VALUELN	1	0.000630	0.00256726	0.245	0.8063
FMATH	1	0.003918	0.00500313	0.783	0.4337
FCOMPUTR	1	-0.000820	0.00255976	-0.320	0.7489
FNEWSKIL	1	0.009159	0.00439408	2.084	0.0373
FCOMM	1	-0.001345	0.00451138	-0.298	0.7657
FSUPER	1	-0.012053	0.00405855	-2.970	0.0030
ACCUPERF	1	0.001488	0.00322679	0.461	0.6448

Dependent Variable: PROFI2YY

Test: TRSP	Numerator:	0.3774	DF:	1	F value:	26.1592
	Denominator:	0.014428	DF:	1186	Prob>F:	0.0001

Dependent Variable: PROFI2YY

Test: WORK	Numerator:	0.0334	DF:	5	F value:	2.3171
	Denominator:	0.014428	DF:	1186	Prob>F:	0.0416

X SECTION OF INDIV--5 reference var--SUBST HIRYY FORTENYY 16:02 Friday, October 11, 1996 62
TR=0 WHEN LEAVE EARLY-ImP vars edited--FORON MISSING EDIT
SYSLIN Procedure
Two-Stage Least Squares Estimation
Model: PGRCR2YY
Dependent variable: PGRCR2YY
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	55	3.54733	0.06450	4.611	0.0001
Error	1127	15.76481	0.01399		
C Total	1182	20.12397			

Root MSE	0.11827	R-Square	0.1837
Dep Mean	0.12235	Adj R-SQ	0.1438
C.V.	96.66697		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	Parameter=0	T for H0: Prob > ITI
INTERCEP	1	-0.091884	0.074477	-1.234	0.2176
TENYY	1	0.015860	0.007034	2.255	0.0243
TENSQYY	1	-0.001760	0.000930	-1.892	0.0588
LTTYY	1	0.032777	0.014145	2.317	0.0207
SPLTTYY	1	-0.000136	0.003649	-0.037	0.9703
YROCCYY	1	-0.002621	0.004112	-0.637	0.5240
SCHYY	1	0.006836	0.002429	2.814	0.0050
EXPYY	1	-0.008203	0.002379	-3.448	0.0006
EXPYYSQ	1	0.000236	0.000092856	2.541	0.0112
AGEYY	1	0.000729	0.001168	0.625	0.5323
AGESQYY	1	0.000004182	0.000029962	0.140	0.8890
BLKYY	1	-0.008568	0.018074	-0.474	0.6356
HISPYY	1	-0.011168	0.018825	-0.593	0.5531
FEMYY	1	0.005597	0.011851	0.472	0.6368
MARYY	1	-0.011020	0.011640	-0.947	0.3440
NEWPAPYY	1	-0.004212	0.009107	-0.463	0.6438
RSUPYY	1	-0.010072	0.007694	-1.309	0.1908
PERSOFYY	1	-0.023551	0.018345	-1.284	0.1995
IGPYY	1	-0.009032	0.008197	-1.102	0.2707
RPREVYY	1	-0.001087	0.008348	-0.130	0.8964
HUSBYY	1	0.017397	0.014432	1.206	0.2283
TONYY	1	-0.005285	0.008394	-0.630	0.5291
TOFYY	1	0.009775	0.014968	0.653	0.5139
TRPUBYY	1	-0.009616	0.011243	-0.855	0.3926
TRPRIYY	1	-0.019029	0.012304	-1.547	0.1222
TRMILYY	1	-0.032840	0.018660	-1.760	0.0787
TRJTPAYY	1	-0.050410	0.026219	-1.923	0.0548
IMPOCCB	1	-0.000498	0.002589	-0.193	0.8474
IMPLRNB	1	0.001765	0.003210	0.550	0.5827
IMPHABB	1	-0.003912	0.003872	-1.010	0.3125
IMPLEADB	1	0.000687	0.003827	0.179	0.8577
IMPREADB	1	-0.005544	0.002808	-1.975	0.0486
CRAFT	1	-0.017014	0.028083	-0.606	0.5447
CONST	1	-0.027861	0.028632	-0.973	0.3307
SREP	1	0.020987	0.029014	0.723	0.4696
RETAIL	1	-0.016282	0.029184	-0.558	0.5770
SERV	1	-0.007510	0.030341	-0.247	0.8046
LAB	1	-0.037111	0.030105	-1.233	0.2179
MANAG	1	-0.013422	0.044310	-0.303	0.7620
CLERK	1	0.006968	0.029404	0.237	0.8127
SEC	1	0.060281	0.030376	1.984	0.0474
TECH	1	0.022382	0.028718	0.779	0.4359
PROF	1	-0.002619	0.031163	-0.084	0.9330
OPER	1	-0.004082	0.030557	-0.134	0.8938
TOPER	1	-0.004791	0.034215	-0.140	0.8887
OTHER	1	0.018104	0.030230	0.599	0.5494
GRTHEMP	1	0.007166	0.007826	0.916	0.3600
PIECE	1	-0.010538	0.009615	-1.096	0.2733
GROUPI	1	0.015948	0.010353	1.540	0.1237
VALUELN	1	0.001290	0.002708	0.476	0.6340
FMATH	1	0.001962	0.005589	0.351	0.7257
FCOMPUTR	1	-0.002571	0.002594	-0.991	0.3219
FNEWSKIL	1	0.011093	0.004848	2.288	0.0223
FCOMM	1	-0.000382	0.005556	-0.069	0.9451
FSUPER	1	-0.010682	0.004409	-2.423	0.0156
ACCUPERF	1	0-000784	0.003235	0.242	0.8087

Test: TRSP

Numerator:	0.064508	DF:	1	F Value:	4.6116
Denominator:	0.013988	DF:	1127	Prob>F:	0.0320

Test: IMP						
Numerator:	0.016857	DF:	5	F Value:	1.2051	
Denominator:	0.013988	DF:	1127	Prob>F:	0.3045	
Test: WORK						
Numerator:	0.03217	DF:	5	F Value:	2.2997	
Denominator:	0.013988	DF:	1127	Prob>F:	0.0431	
Test: RC						
Numerator:	0.013375	DF:	5	F Value:	0.9561	
Denominator:	0.013988	DF:	1127	Prob>F:	0.4437	
Test: OCC						
Numerator:	0.029349	DF:	14	F Value:	2.0981	
Denominator:	0_013988	DF:	1127	Prob>F:	0.0100	

Appendix: Derivation

Derivatives of Probabilities

With respect to W^2:

$\partial \Pr(K)/\partial W^2 = -\phi_0$ $\quad$ $\partial \Pr(S)/\partial W^2 = \phi\,(1 - \frac{\phi_0}{\Pr(K)^2} F_b) = \phi\,(1-v)$

With respect to g:

$\partial \Pr(K)/\partial_g = \phi_0$ $\quad$ $\partial \Pr(S)/\partial_g = \phi\,(-U_g + \frac{\phi_0}{\Pr(K)^2} F_b) = \phi\,(-U_g + v)$

With respect to h:

$\partial \Pr(K)/\partial h = \phi_0$ $\quad$ $\partial \Pr(S)/\partial h = \phi\,(\frac{\phi_0}{\Pr(K)^2} F_b) = \phi v$

Derivatives of the Conditional Expectations

E(∈$_0$I K)

Definition:

$$E(\in_0 | K) = \int_{W^2-P-g-h}^{\infty} t f_0(t)\,dt / \Pr(K)$$

$$\partial E(\in_0 |K)/\partial W^2 = \frac{-(W^2-P-g-h)f_0}{\Pr(K)} - \frac{\int t f_0 dt}{\Pr(K)^2}\cdot\frac{\partial \Pr(K)}{\partial W^2} = \frac{f_0}{\Pr(K)}[-(W^2-P-g-h)+E(\in_0|K)] = \frac{f_0}{\Pr(K)}Q_a$$

$$\frac{\partial E(\in_0 |K)}{\partial W^2} = \frac{f_0}{\Pr(K)}Q_a$$

$$\frac{\partial E(\in_0 |K)}{\partial g} = \frac{f_0}{\Pr(K)}Q_a$$

$$\frac{\partial E(\in_0 |K)}{\partial h} = \frac{f_0}{\Pr(K)}Q_a$$

E(∈I S)

Definition:

$$E(\in |S) = \int_{-\infty}^{W^2-U+T-\frac{1-\Pr(K)}{\Pr(K)}F_b} t\cdot f(t)\,dt/\Pr(S)$$

$$\partial E(\in |S)/\partial W^2 = \{\frac{W^2 - U + T - (1-\Pr(K))/\Pr(K)\cdot F_b\}f}{\Pr(S)} - \frac{\int t f dt}{\Pr(S)^2}\cdot f\}\cdot(1-v)$$

$$= \frac{f}{\Pr(S)}\{W^2 - U + T - (1 - \Pr(K)/\Pr(K) \cdot F_b - E(\in \mid S)\} \cdot (1-v) = \frac{f}{\Pr(S)} Q_b * (1-v)$$

$$\frac{\partial E(\in \mid S)}{\partial W^2} = \frac{f}{\Pr(S)} Q_b * (1-v)$$

$$\frac{\partial E(\in \mid S)}{\partial g} = \frac{f}{\Pr(S)} Q_b * (-U_g + v)$$

$$\frac{\partial E(\in \mid S)}{\partial h} = \frac{f}{\Pr(S)} Q_b * \cdot v$$

Differentiation of (*) Pr(S) Pr(K) G_a
(G_a = P+g+h+E($\in_0$I K) – W^2)

$$\partial Q_a / \partial W^2 = \frac{f_0}{\Pr(K)} Q_a - 1$$

$$\partial Q_a / \partial g = 1 - \frac{f_0}{\Pr(K)} Q_a$$

$$\partial Q_a / \partial h = 1 - \frac{f_0}{\Pr(K)} Q_a$$

w.r.t.w^2

$$\{\partial \Pr(S)/\partial W^2 \cdot \Pr(K) + \partial \Pr(K)/\partial W^2 \cdot \Pr(S)\} Q_a + \Pr(S)\Pr(K) \cdot \partial Q_a / \partial W^2$$

$$= \{\partial \Pr(S)/\partial W^2 \cdot \Pr(K) - f_0 \Pr(S)\} Q_a + \Pr(S)\Pr(K)(\frac{f_0}{\Pr(K)} Q_a - 1)$$

$$= \partial \Pr(S)/\partial W^2 \cdot \Pr(K) Q_a - \Pr(S)\Pr(K)$$

w.r.t.g

$$\partial \Pr(S)/\partial g \cdot \Pr(K) \cdot Q_a + \Pr(S)\Pr(K)$$

w.r.t.h

$$\partial \Pr(S)/\partial h \Pr(K) Q_a + \Pr(S)\Pr(K)$$

Differentiation of (**) Pr(S)Pr(K)Q_b*

$$(Q_b{*} = W^2 - U + T - E(\in |S) - (1-\Pr(K))/\Pr(K)F_b = Q_b - \frac{F_b}{\Pr(K)})$$

$$\partial Q_b{*}/\partial W^2 = 1 - \frac{f}{\Pr(S)}Q_b{*}(1-v) - v = (1-v)(1-\frac{f}{\Pr(S)}Q_b{*})$$

$$\partial Q_b{*}/\partial g = -U_g - \frac{f}{\Pr(S)}Q_b{*}(-U_g + v) + v = (-U_g + v)(1-\frac{f}{\Pr(S)}Q_b{*})$$

$$\partial Q_b{*}/\partial h = -\frac{f}{\Pr(S)}Q_b{*}v + v = v(1-\frac{f}{\Pr(S)}Q_b{*})$$

---

w.r.t.w^2

$$\{\partial \Pr(S)/\partial W^2 \Pr(K) + \partial \Pr(K)/\partial W^2 \Pr(S)\}Q_b{*} + \Pr(S)\Pr(K)(1-v)(1-\frac{f}{\Pr(S)}Q_b{*})$$

$$= \{f(1-v)\Pr(K) + \partial \Pr(K)/\partial W^2 \Pr(S)\}\cdot Q_b{*} + \Pr(S)\Pr(K)(1-v)(1-\frac{f}{\Pr(S)}Q_b{*})$$

$$= \partial \Pr(K)/\partial W^2 \Pr(S)Q_b{*} + \Pr(S)\Pr(K)(1-v)$$

$$= -f_0 \Pr(S)Q_b{*} + \Pr(S)\Pr(K)(1-v)$$

$$= -f_0 \Pr(S)(Q_b - \frac{1}{\Pr(K)}F_b) + \Pr(S)\Pr(K) - \Pr(S)\Pr(K)v$$

$$= \Pr(S)\Pr(K) - f_0 \Pr(S)Q_b$$

w.r.t.g

$$f_0 \Pr(S)Q_b$$

Since the objective function and constraint are given by

$$MaxP - C(g,h) - W^1 + d_a \frac{[\Pr(K)\Pr(S)Q_a]}{(*)}$$

$$s.t. R \le W^1 + d_b[\frac{\Pr(S)\Pr(K)Q_b{*}}{(**)} + U - T],$$

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

Derivation of (13')

Denote K = Pr(K), S = Pr(S), K' = ∂Pr(K)/∂W^2, S' = ∂Pr(S)/∂W^2. The foc for W^2 is written as

$$\delta_a[S'KQ_a-SK] + \delta_b[SK+K'SQ_b] = 0$$

Q_a= P+g+h+E ($\in_0$ I K)-W^2, x_1= P+g+h+E($\in_0$ I K)
Q_b*= W^2-P-g+T-E(∈ I S) +F_b=W^2+x_2, x_2= P+g-T+E(∈ I S)-F_b

Define ^S=S'/S (>0) and ^K=K'/K (<0), and dividing through by SK the foc is rewritten as

δ_a[^S(X_1-W^2)-1] + δ_b{1+^K(W^2+X_2)]=0

W^2(δ_a^S-δ_b^K)=$\delta_a^{S}X_1$-δ_a+δ_b+$\delta_b^{K}X_2$

$$W^{2=} = X_1 \; -q\,(X_1 - X_2) - \frac{d_a - d_b}{d_a S - d_b K},$$

where $q = \frac{-d_b \wedge K}{d_a S - d_b K} = \frac{d_b{}^t K}{d_s{}^t S + d_b{}^t} W^2,$ and

$$X_1 - X_2 = (g - \wedge g) + h + E(\in \left|K\right.) + T = E(\in \left|S\right.) + F_b$$

Thus,

$$(15')W^2 = P + g + h + E(\in_0 \left|K\right.) - q[(g - \wedge g) + h + E(\in_0 \left|S\right.) + F_b] - \frac{d_a - d_b}{d_a{}^t{}_s + d_b{}^t{}_K} W^2$$

Derivation of (14' and 15')

The foc for g and W^2 are

$$(7')C_g = d_a[f(v-b)KQ_a + SK] + d_b[(1-SK)b + f_0 SQ_b],$$

$$(5')0 = d_a[f(1-v)KQ_a - SK] + d_b[SK - f_0 SQ_b]$$

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

(12') $C_g = d_a f(1-b)KQ_a + d_b\{(1-SK)b + SK\}$

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

(12'') $C_g = d_a SK(\frac{1-b}{1-v}) + d_b\{b + f_0 SQ_b(\frac{1-b}{1-v}) - \frac{v(1-b)}{1-v} SK\}$

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'):

$$(6')C_h = d_a[SK + fvKQ_a] + d_b f_0 SQ_b,$$
$$(5')0 = d_a[f(1-v)KQ_a - SK] + d_b[SK - f_0 SQ_b$$

yields,

$$(12.5')C_h = d_a fKQ_a + d_b SK,$$

or <u>removal</u> of Q_a yields

$$(12.5'')C_h = d_a SK(\frac{1}{1-v}) + d_b[-SK(\frac{v}{1-v}) + f_0 SQ_b(\frac{1}{1-v})]$$

Note: $-SK(\frac{v}{1-v}) + f_0 SQ_b(\frac{1}{1-v}) = \frac{f}{1-v}\Pr(S)Q_b *$