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PRODUCTIVITY GAINS FROM THE IMPLEMENTATION OF EMPLOYEE TRAINING PROGRAMS

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ABSTRACT

This paper utilizes data on the personnel policies and economic characteristics of businesses in the manufacturing sector to study the relationship between employee training and labor productivity. The major finding is that businesses that were operating below their expected labor productivity levels in 1983 implemented new employee training programs after 1983 which resulted in significantly larger increases in labor productivity growth between 1983 and 1986. This higher rate of productivity growth was sufficient to bring these businesses up to the labor productivity levels of comparable businesses by 1986. The positive effects of training implementation on productivity growth were shown to be inconsistent with a "Hawthorne Effect" interpretation because the implementation of new personnel policies other than training did not have significant effects on productivity growth.

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I. Introduction

A recent report prepared by the congressional Office Of Technology Assessment (1990) concluded that American workers need more training if the United States is to remain internationally competitive. The basic premise of the OTA's report was that training enhances labor productivity and American workers are less productive than their foreign counterparts because of inadequate training. A number of labor economists have attempted to empirically demonstrate the relationship between training and labor productivity utilizing data on individual workers. Since data on labor productivity are very limited, these studies take an indirect approach, relying on the observed relationship between training and wages as evidence of a relationship between training and productivity (e.g. Brown, 1989; Lillard and Tan, 1986; Lynch, 1988). Two exceptions are the papers by Bishop (1990) and Holzer et.al. (1991). The work by Bishop uses the data from the Employment Opportunites Pilot Projects (EOPP) Survey to document the increase in the productivity of newly hired employees that occurs as a result of their participation in company training programs. The paper by Holzer et.al. uses a survey of Michigan manufacturing firms that applied for state-funded training grants and

finds that firms that provide more formal training have higher quality work produced by their employees.

In light of the national attention given to the impact of training on labor productivity, it is disturbing that the empirical evidence on this subject is so limited. Indeed, one of the themes of the recent IRRA volume on worker training (Ferman et. al, 1990) was that too much of the research on the effects of training has been done at the individual level and not enough at the organizational level. The research presented in this paper is an attempt to fill this gap. Specifically, I analyze how labor productivity measured at the level of the business unit is affected by the implementation of formal employee training programs. This relationship is measured within the framework of a properly specified labor productivity equation. This unique approach to the study of the impact of training on productivity is facilitated by the use of a database that contains information on the economic performance as well as the human resource management policies of U.S. businesses.

Section II provides an empirical framework for analyzing the impact of training on labor productivity in the firm. The data and variables that are used for empirical estimation are described in

Section III. Findings are presented in Section IV and conclusions and directions for future research are discussed in Section V.

II. Empirical Framework and Data

For simplicity, assume that the production functions for the businesses studied can be represented by a Cobb-Douglas function and that there are two inputs in the production process, capital, K, and "effective labor", EL. Effective labor is the amount of labor services that are actually supplied by the workers that the company employs. Let the number of workers employed be represented by the variable, RL, or reported labor. EL and RL are related according to the equation $EL = RL(1 + \lambda)$. The use of formal employee training programs will modify the relationship between EL and RL as shown in the following equation:

$$(1) \qquad EL = RL(1 + \lambda T)$$

where T measures the training that the business provides its employees. According to equation (1), as T increases, the gap between EL and RL widens. The production function can be written as:

$$(2) \qquad Q = AK^{\beta}EL^{\gamma}$$

or substituting equation (1) into (2), results in:

$$Q = AK^{\beta}(RL(1+\lambda T))^{\gamma} \tag{2a}$$

In the data I observe output per worker, or Q/RL, which is written in equation (3) as:

$$Q/RL = AK^{\beta}RL^{\gamma-1}(1+\lambda T)^{\gamma} \tag{3}$$

Taking logarithms of both sides of equation (3) and adding a vector of control variables, X, as well as a random component, gives the labor productivity equation that will be estimated:[1]

$$\ln (Q_t/R_t) = \ln A + \beta \ln K_t + (\gamma-1)\ln RL_t + \gamma\lambda T_t + \alpha X_t + \epsilon_t \tag{4}$$

Estimates of the coefficient on the variable T will be biased, however, if the error term is correlated with T. This could happen, if, for example, businesses that have low levels of labor productivity due to some unobserved characteristic, also have high values of T perhaps because they are using training to raise productivity. The converse could also be true: businesses that have high labor productivity may be better able to pay for the cost of a formal

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[1]The equation (4) transformation uses the approximation $\ln(1 + x) \cong x$ for small x.

training program and therefore have high values of T. Either of these situations can be handled by estimating a first difference model in which the change in the logarithm of labor productivity is regressed on changes in the independent variables:

$$(5)\quad \ln (Q_t/RL_t) - \ln(Q_{t-1}/RL_{t-1}) = \beta(\ln K_t - \ln K_{t-1}) + (\gamma - 1)(\ln RL_t - \ln RL_{t-1}) + \gamma\lambda (T_t - T_{t-1}) + \mu_t - \mu_{t-1}$$

In equation (5), all unobserved fixed effects that might be correlated with any of the independent variables are removed, along with the variables in vector X that are permanent observed characteristics of the businesses. Section IV will report the results of estimating both the level equation shown in equation (4) and the change equation shown in equation (5).

III. Data and Variables

The businesses that are studied are taken from a 1986 Columbia Business School survey that covered 495 Compustat II business lines.[2] The purpose of this survey was to gather

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[2]These businesses are not a random sample of all U.S. businesses. No such random sample exists. As discussed in Delaney, Lewin and Ichniowski (1989), this is the largest data set in existence that contains information on both personnel policies and economic performance. Delaney, Lewin and Ichniowski show that the sample does closely match the industrial distribution of all 1986

information on a broad range of human resource management policies, one of which is employee training. For those firms that operate only one business line, a "business line" corresponds directly to the company. When a parent company operates several business lines, a "business line" generally corresponds to a division of a company. For each of the businesses in the sample, Q is measured by "net sales" from the Compustat II data tape and K is measured by "identifiable capital assets" from that tape. Reported labor, RL, reported in the Columbia survey, is measured as the number of employees in the business unit. Since output per worker is proxied by net sales per worker, equation (4) must be modified to control for the costs of purchased materials in order to get the appropriate value added measure. Although the Compustat II data does not report this information, data from the Census of Manufacturers on the ratio of the cost of purchased materials to the dollar value of shipments for the business's four-digit industry can be used. This necessitates limiting the study to the businesses in the manufacturing sector, a limitation which is actually beneficial in that

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Compustat II business lines. The reader is cautioned, however, that it may be inappropriate to extrapolate the results presented in this paper to the full set of Compustat II business lines.

it minimizes the problem of comparing labor productivity across businesses in diverse sectors of the economy.[3]

Equation (4) requires an estimate of T, a measure of training in the organization. The Columbia survey asked whether the business had a formal training program for each of the following employee groups: managers, union and nonunion professional and technical employees, union and nonunion clerical employees, and union and nonunion production workers. If the business indicated that it had a formal training program for any employee group, it then was asked to provide the year in which that training program was implemented. As will be shown below, this piece of information is critical to the proper estimation of the productivity gains from training programs. Although the survey included a question regarding the annual cost of the training program, the response rate for this question was extremely low.[4] The survey did not ask for information on the

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[3]Approximately 180 businesses in the survey are in the manufacturing sector.

[4]Bartel (1991) shows that the likelihood of a response to this question was not dependent on company size, productivity, or industry sector. Interviews with a small number of survey respondents indicated that the businesses could not respond to this question because their organizatiions did not maintain a separate line item for training in the budget, or they were not sure what categories of expenditures should actually be included in the response to the question. As Bartel (1991) demonstrates, this problem has been encountered in other surveys of corporate training.

amount of time employees spend in the training program. Hence, the best measure of T in this database is a dummy variable indicating whether or not the business had a formal employee training program.[5] Within this framework, effective labor, EL, equals reported labor, RL, if the business does not have a training program and EL exceeds RL if a training program that raises worker productivity exists in the firm.

Several other variables are included in equation (4). First is a measure of the age of the business line, proxied by the age of the business's oldest plant or facility as indicated in the responses to a survey question on the age distribution of the business's plants. This variable is included because of theoretical and empirical evidence on the relationship between the age of the business and the level of labor productivity.[6] Second is the percentage of the

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[5]Although it would be preferable to have a measure of amount of training, as is provided for example in the EOPP database, the database I am using has the important advantage of containing information on each company's economic performance. Since the focus of this study is the productivity gains from training, the database must contain the relevant economic data.

[6]According to the product life-cycle theory, the age of the business will be correlated with the level of labor productivity. Young businesses have low levels of labor productivity because their technology has not yet been well defined and their employees devote a significant amount of their time to designing and redesigning an appropriate production technology. See Bartel and Lichtenberg (1987) for evidence on the relationship between an

business's employees that are unionized.[7] Third is a set of dummy variables indicating the use of other personnel policies that could influence the gap between effective labor and reported labor. The three policies that are studied are: (1) a formal job design program, (2) a formal performance appraisal system, and (3) an employee involvement or quality circle program.[8] Including these three policies requires expanding equation (1) to include three new additive terms within the parentheses. Fourth, a vector of dummy variables for each of the two-digit SIC categories in manufacturing is added to the labor productivity equation in order to control for systematic differences in the measurement of labor productivity across diverse businesses in the manufacturing sector.

In order to estimate equation (5), information from a prior year is needed for the businesses in the sample. Since the names and

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industry's labor productivity and the age of its plant.

[7]Freeman and Medoff (1984) summarize recent evidence on the relationship between labor productivity and unionization.

[8]The Columbia survey also obtained information on other personnel policies such as merit pay, pay for seniority, layoffs based on seniority, and provision of specific fringe benefits. The three policies listed in the text were the only ones, in addition to training, for which there was information on the year the policy was implemented. Since this type of information is critical for estimating the impact of a personnel policy on labor productivity, the analysis only included the three policies listed in the text.

addresses of the businesses that were studied were obtained from the 1983 Compustat address file, information on the business's 1983 labor productivity, 1983 employees and 1983 identifiable assets was matched with the 1986 database. Data on the 1983 materials/sales ratio were also obtained from the Census of Manufacturers. The change in the training index, $T_t - T_{t-1}$, is measured by using information from the survey on the year the training program was implemented. In particular, if the business implemented the training program after 1983, then the change in the training index equals one. For businesses that have no training program or those that implemented the program in 1983 or earlier, the change in the training index is coded as zero. A similar methodology is used to measure the change in the other personnel policies that are included in the equation (i.e. job design, performance appraisal and employee involvement programs). Businesses that implemented these programs after 1983 are coded one for the change variable and those that either implemented in 1983 or earlier, or do not have the program, are coded zero. The other variables in the X vector are eliminated from equation (5) either because they measure permanent attributes of the business (e.g. two-digit SIC category) or because the information needed to code the change variable was unavailable (i.e. there is no

information on age of the business or percentage of employees unionized in 1983).

Summary statistics for the dependent and independent variables are given in Appendix Table A-1.

IV. Results

In the first step of the analysis, equation (4) is estimated using 1986 labor productivity as the dependent variable. Table 1 presents the coefficients and t-values on dummy variables indicating the presence of a formal employee training program in 1986 for each of four employee groups, i.e. managers, professional/technical workers, clerical workers, and manufacturing/production workers. The labor productivity equation is estimated four times in order to show the distinct effects of the personnel policies used for each of the four occupation groups. Column (1) shows the effect of training programs without controlling for the other personnel policies. Column (2) shows the coefficients on training from equations that include the other personnel policies. The complete equations are shown in Appendix Table A-2. The results in Table 1 show that there are no significant differences in labor productivity between businesses that have formal employee training programs and those

that do not.[9] Controlling for the other personnel policies has no impact on the training coefficients.

As discussed in section II, estimating the relationship between training programs and labor productivity using a cross-sectional framework does not allow us to untangle the effect of training on productivity from the effect of productivity on the use of a formal training program. It is possible that those businesses with formal training programs have indeed experienced increases in productivity that are attributable to the programs. But, a cross-sectional framework would not reveal this if these businesses have current levels of labor productivity that are no higher than businesses that do not have formal training programs. By estimating equation (4) using 1983 values for labor productivity, assets, employment, and the materials/sales ratio, and including dummy variables for the post-1983 implementation of training programs and the other personnel-related programs, we can determine whether the implementers were operating at productivity levels lower than expected given their levels of assets, employment and materials/sales ratio.

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[9]For the three other personnel policies, the only time a significant coefficient appears is in the case of an employee involvement program for production workers which is significant at the ten percent level. See Appendix Table A-2.

Table 2 provides information on the businesses that implemented employee training programs after 1983. Column 1 shows the number of businesses that did not have training programs in 1983 and column 2 shows the percentage of these businesses that implemented training programs after 1983. The coefficients and t-values on the post-1983 training variables from the 1983 labor productivity equation are shown in Column 3. The complete regressions are given in Appendix Table A-3. The four training implementation variables are negative and two are significant in Column (3), indicating that the implementers were operating at the same or lower labor productivity levels in 1983 than the non-implementers.[10] Appendix Table A-3 shows that post-1983 implementation of the other policies was not correlated with 1983 labor productivity. This result is important because it demonstrates that low productivity did not motivate companies to try anything new, but rather to specifically implement training.

The next step in the analysis is to estimate equation (5) where the dependent variable is the change in the logarithm of labor productivity. The coefficients on post-1983 implementation of training from this equation are shown in columns (1) and (3) of

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[10]The coefficients on training implementation remain the same when the other personnel policies are deleted.

Table 3 and the complete set of regressions is given in Appendix Table A-4. In all four cases, the implementation of a formal employee training program led to a significant increase in labor productivity growth that was unaffected by the inclusion of the other personnel policy variables.

Since the businesses that implemented training programs were shown to have low levels of productivity in 1983, it is possible that the implementers were only experiencing "regression to the mean", i.e. an improvement in productivity that would have happened even without the new training program. To examine this possibility, the labor productivity growth equation was reestimated including 1983 labor productivity as a regressor. If the training program implementers were just experiencing relatively high productivity growth that any business with relatively low levels of productivity did, then the inclusion of the 1983 productivity value should cause the coefficients on the training implementation variables to go to zero. The coefficient on 1983 labor productivity will be negative if regression to the mean did indeed occur.

The results in columns (2) and (4) of Table 3 show that there was regression to the mean. Businesses with low levels of productivity, regardless of whether they implemented training programs after 1983, experienced significantly higher rates of

productivity growth after 1983. In spite of this, however, the implementation of employee training programs still had a positive and significant effect on productivity growth. In particular, the rate at which productivity grew between 1983 and 1986 was at least 17 percent higher for businesses that implemented new training programs. The full regressions in Appendix Table A-4 show that a "Hawthorne Effect" interpretation of these results is incorrect. This interpretation would imply that doing anything new makes a difference, and, therefore, that implementation of other new personnel policies should have a significant effect on productivity growth. The results in Appendix Table A-4 show that there is no policy besides training that has a positive and significant effect on productivity growth in all four cases. Job design never has a significant effect, performance appraisal systems are only significant for managers, and employee involvement programs are only significant in the case of professional/technical workers. Implementation of employee training programs stands out as the only program that consistently has a positive impact on productivity growth.

Table 3 provides solid evidence that businesses that implement training programs experience significant increases in productivity growth. Recall that in Table 2 we observed that these

businesses started from the same or lower productivity level, i.e. their 1983 labor productivity was the same as or significantly lower than the labor productivity of comparable businesses. We can now consider whether the implementation of a training program helped the implementers to jump ahead of comparable businesses. This is accomplished by estimating a 1986 labor productivity equation that uses a dummy variable for the implementation of a training program after 1983, with control variables for the post-1983 implementation of the other personnel policies, and 1986 values for the other variables that belong in the equation. Table 4 reports the coefficients and t-values on the post-1983 implementation of training programs. The complete set of regressions from which these coefficients are drawn is given in Appendix Table A-5. Recall from Table 2 that the businesses that implemented training programs for their professional/technical workers or their clerical employees were operating at 1983 labor productivity levels that were significantly lower than comparable businesses. The results in Table 4 show that, by 1986, the implementers have caught up to their competitors; there is no significant difference between the 1986 productivity levels of the implementers and the comparable businesses. Businesses that implemented training programs for their managers or manufacturing workers were operating at 1983

productivity levels that were numerically, but not significantly, lower than comparable businesses. In 1986, the businesses that implemented training for their managers were no better off than comparable businesses, while those that implemented for manufacturing employees were at productivity levels that were close to being significantly higher than the other businesses. Hence, we can conclude that the implementation of formal employee training programs can enable businesses that are operating at below-expected levels of labor productivity to eliminate this gap. Businesses that start from the same labor productivity level as their competitors experience gains in productivity that sometimes exceed their competitors' gains.

V. Conclusions

This paper has offered a new approach to the study of employee training and labor productivity. Unlike previous research which has relied on data on individual employees, this study utilized data on the personnel policies and economic characteristics of businesses in the manufacturing sector. The major finding is that businesses that were operating below their expected labor productivity levels in 1983 implemented new employee training programs after 1983 which resulted in significantly larger increases

in labor productivity growth between 1983 and 1986. This higher rate of productivity growth was sufficient to bring these businesses up to the labor productivity levels of comparable businesses by 1986. When implementers started at the same level as their competitors, they sometimes experienced productivity gains that exceeded the competitors' gains. The positive effects of training implementation on productivity growth were shown to be inconsistent with a "Hawthorne Effect" interpretation because the implementation of new personnel policies other than training did not have significant effects on productivity growth. Formal employee training programs are unique in their ability to bring below-average firms up to the performance level of comparable businesses.

The findings in this paper are important because they show that a relationship between training and labor productivity exists, not only at the level of the individual employee, as demonstrated in previous work, but on an organizational level as well. Certainly much more work needs to be done to analyze the various dimensions of formal employee training programs, e.g. time spent by employees in training, dollars expended for the programs, etc, as well as to measure the long-run effect of formal training. Unfortunately, the database used for this paper could not answer

these questions. It is clear that more complete data on training in business organizations needs to be collected. Hopefully, the findings that were presented here will stimulate greater awareness of the need to collect such data in order to encourage further research on the measurement of the relationship between training and productivity on an organizational level.

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Table 1
The Effect of Formal Employee Training Programs on 1986 Labor Productivity*
(t-values are shown in parentheses)

	(1)		(2)		
Employee Group	b	t	b	t	Percent with a Program
MANAGERS	.06	(.64)	.07	(.69)	37.7%
PROF/TECH	.02	(.25)	.04	(.40)	35.6%
CLERICAL	-.001	(-.01)	-.003	(-.02)	23.4%
MFG/PROD	-.01	(-.09)	-.03	(-.31)	32.4%
Controls for Other Personnel Policies	No		Yes		

*Other variables included in the equations are the logarithm of identifiable capital assets, the logarithm of number of employees, the logarithm of the ratio of materials costs to value of shipments in the business's four-digit industry, age of the business, percentage of employees that are unionized,and a vector of dummy variables for 2-digit SIC categories. See Appendix Table A-2.

Table 2

Post-1983 Implementation of Training Programs

	(1) # Businesses without Programs in 1983	(2) % Implementing after 1983	(3) Coeff. and t-value from 1983 LPROD Eq.*
Employee Group			
MANAGERS	114	19.2%	-.16 (-1.20)
PROF/TECH	108	12.0%	-.34 (-1.96)
CLERICAL	121	4.1%	-.47 (-1.85)
MFG/PROD	113	11.5%	-.07 (-0.41)

*Coefficients and t-values are taken from 1983 labor productivity equations which are shown in Appendix Table A-3.

Table 3
The Impact of Implementing A Formal Training Program on 1983-1986 Productivity Growth*
(t-values are given in parentheses)

	Without Controls For Other Personnel Policies		With Controls For Other Personnel Policies	
Employee Group	(1)	(2)	(3)	(4)
MANAGERS				
New Training Program	.18	.17	.20	.18
	(2.42)	(2.25)	(2.56)	(2.38)
1983 Productivity		-.01		-.01
		(-2.79)		(-2.67)
PROFESSIONALS				
New Training Program	.31	.27	.32	.27
	(3.33)	(2.91)	(3.24)	(2.74)
1983 Productivity		-.01		-.01
		(-2.52)		(-2.56)
CLERICAL WORKERS				
New Training Program	.60	.60	.55	.56
	(4.24)	(4.35)	(3.83)	(3.95)
1983 Productivity		-.01		-.01
		(-2.88)		(-2.79)
PRODUCTION WORKERS				
New Training Program	.25	.23	.22	.20
	(2.67)	(2.51)	(2.04)	(1.90)
1983 Productivity		-.01		-.01
		(-2.73)		(-2.87)

* Coefficients and t-values are taken from labor productivity change equations which are shown in Appendix Table A-4.

Table 4

The Impact of Implementing a Formal Training Program on Subsequent Productivity Levels*

(t-values are given in parentheses)

Employee Group	b	t	b	t
MANAGERS	.03	(.27)	.03	(.27)
PROF/TECH	-.005	(-.03)	-.003	(-.02)
CLERICAL	-.07	(-.32)	-.08	(-.35)
MFG/PROD	.22	(1.40)	.21	(1.28)
Controls for Other Policies	No		Yes	

*Coefficients and t-values are taken from 1986 productivity equations which are shown in Appendix Table A-5.

Table A-1
Summary Statistics for 1986

	Mean	Std. Dev
Labor Productivity	.23	.80
% Chg in Labor Prod. 1983-1986	.29	.60
# Employees	7191.5	22459.8
% Unionized	.16	.24
Age of Business (years)	23.24	12.37
Assets (millions $)	998.01	5769.6
% with training for mgrs	37.7	48.6
% with training for prof.	35.6	48.0
% with training for cler.	23.4	42.5
% with training for prod.	32.4	46.9
% with job design for mgr	30.5	46.2
% with job design for prof.	35.6	48.0
% with job design for cler.	35.1	47.9
% with job design for prod.	33.8	47.5
% with prof. app. for mgr	89.4	30.9
% with perf app. for prof.	92.6	26.2
% with perf. app. for cler	92.2	26.9
% with perf app. for prod	77.2	42.1
% with emp. inv. for mgrs.	37.1	48.4
% with emp. inv. for prof.	35.6	48.0
% with emp. inv. for cler.	39.6	49.1
% with emp. inv. for prod.	51.7	50.1

Table A-2

Dependent Variable: Ln (1986 Labor Productivity)*

(t-values in parentheses)

	Managers	Prof/Tech	Clerical	Production
Training Program	.07	.04	-.003	-.03
	(.69)	(.40)	(-.02)	(-.32)
Job Design	-.05	-.05	-.007	-.04
	(-.51)	(-.53)	(.07)	(-.45)
Perf. Appraisal	.05	.12	.21	.05
	(.36)	(.73)	(1.31)	(.45)
Emp. Involvement	.02	.04	.04	.15
	(.19)	(.39)	(.36)	(1.64)
Ln (Assets)	.80	.81	.82	.80
	(19.08)	(19.24)	(20.53)	(18.69)
Ln (Employees)	-.84	-.84	-.84	-.83
	(-17.95)	(-17.85)	(-18.92)	(-17.05)
Ln (Materials/Sales)	.37	.37	.30	.32
	(1.46)	(1.46)	(1.27)	(1.35)
Age of Business	.005	.007	.008	.006
	(1.38)	(1.57)	(1.83)	(1.48)
% Unionized	.28	.30	.40	.39
	(1.23)	(1.28)	(1.82)	(1.72)
Intercept	.08	-.03	-.16	-.08
	(.23)	(.09)	(-.44)	(-.22)
R^2	.81	.81	.82	.80

* Regressions also include vector of dummies for 2-digit SIC categories.

Table A-3

Dependent Variable: Ln (1983 Labor Productivity)*

(t-values in parentheses)

	Managers	Prof/Tech	Clerical	Production
New Training	-.16	-.34	-.47	-.07
After 1983	(-1.20)	(-1.96)	(-1.85)	(.42)
New Job Design	.21	.10	-.06	.09
After 1983	(.85)	(.48)	(-.31)	(-.47)
New Perf Appraisal	-.13	-.02	-.03	.08
After 1983	(-.80)	(-.14)	(-.20)	(.53)
New Emp. Inv.	-.21	-.17	-.09	-.11
After 1983	(-1.36)	(-1.08)	(-.62)	(-.93)
Ln (Assets)	.74	.74	.74	.68
	(15.02)	(15.31)	(15.61)	(12.88)
Ln (Employees)	-.75	-.76	-.75	-.67
	(-13.99)	(-14.27)	(-14.31)	(-11.63)
Ln (Materials/Sales)	.41	.50	.43	.36
	(1.34)	(1.62)	(1.51)	(1.30)
Age of Business	.01	.01	.01	.004
	(1.59)	(1.73)	(1.68)	(1.03)
% Unionized	.31	.25	.31	.22
	(1.19)	(.98)	(1.25)	(.89)
Intercept	-.16	-.05	-.20	-.49
	(-.38)	(-.14)	(-.57)	(-1.30)
R^2	.75	.76	.76	.71

* Regressions include a vector of dummies for 2-digit SIC categories.

Table A-4

Dependent Variable: 1983-1986 Percent Change in Labor Productivity

(t-values in parentheses)

	Managers	Prof/Tech	Clerical	Production
New Training After 1983	.18 (2.38)	.27 (2.74)	.55 (3.95)	.20 (1.90)
New Job Design After 1983	-.27 (-2.19)	-.11 (-1.07)	.04 (.42)	.02 (.22)
New Perf. Appraisal After 1983	.22 (2.44)	.11 (1.31)	.04 (.59)	-.02 (-.23)
New Emp. Inv After 1983	.11 (1.28)	.18 (2.20)	.11 (1.39)	.09 (1.19)
Chg. in Ln (Assets)	.64 (14.18)	.66 (14.50)	.68 (17.18)	.67 (15.76)
Chg. in Ln (Employees)	-.88 (-13.87)	-.90 (-14.12)	-.93 (-16.28)	-.90 (-14.31)
Chg. in Ln (Mat/Sales)	.37 (.80)	.68 (1.44)	.60 (1.31)	.59 (1.18)
Ln (1983 Labor Prod)	-.01 (-2.67)	-.01 (-2.56)	-.01 (-2.79)	-.01 (-2.87)
Intercept	.08 (2.08)	.06 (1.61)	.06 (1.79)	.08 (2.17)
R^2	.70	.71	.77	.75

Table A-5

Dependent Variable: Ln (1986 Labor Productivity)*

(t-values in parentheses)

	Managers	Prof/Tech	Clerical	Production
New Training After '83	.03 (.27)	.003 (-.02)	-.08 (-.35)	.21 (1.28)
New Job Design After '83	-.07 (-.30)	-.05 (-.27)	-.09 (-.50)	-.07 (-.39)
New Perf.Appraisal After '83	.05 (.37)	.11 (.76)	.07 (.55)	.14 (1.03)
New Emp. Inv. After '83	-.09 (-.65)	.02 (.12)	.06 (.42)	-.06 (-.55)
Ln (Assets)	.81 (19.24)	.82 (19.10)	.82 (20.19)	.80 (18.56)
Ln (Employees)	-.83 (-17.79)	-.83 (-17.85)	-.83 (18.16)	-.81 (-16.74)
Ln (Materials/Sales)	.32 (1.23)	.31 (1.18)	.24 (.98)	.22 (.93)
Age of Business	.01 (1.42)	.01 (1.59)	.01 (1.58)	.01 (1.59)
% Unionized	.31 (1.29)	.28 (1.22)	.35 (1.57)	.33 (1.50)
Intercept	.04 (-.10)	-.001 (-.004)	-.07 (.19)	-.19 (-.55)
R^2	.81	.81	.82	.80

* Regressions include a vector of dummies for two-digit SIC categories.