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THE ECONOMIC PERFORMANCE OF SURVIVORS AFTER LAYOFFS: A PLANT-LEVEL STUDY

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ABSTRACT

This study tests for the empirical relationship between layoffs and the economic performance of workers who remain after the layoffs. Previous studies performed in laboratory settings have often found increases in the efficiency of workers after layoffs. This analysis is the first to test for this relationship using operating data from a set of similar establishments. Within the framework of a modified Cobb-Douglas production function, layoffs do not influence subsequent productivity in the establishments in this study's sample. It is also suggested that the seniority systems governing layoffs and the high levels of capital intensity in these establishments may help explain the difference between the findings in the laboratory studies and those obtained in this analysis.

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I. INTRODUCTION

While many aspects of the decision to layoff workers have been the focus of various economic studies, a growing body of psychologically-based studies of worker behavior suggests another dimension of layoffs yet to be explored in the economic literature: the impact of layoffs on those not laid off -- the "survivors." These studies describe a set of potential cognitive or emotional responses among those who remain after a layoff that can affect their effort, attention or motivation as well as their attitudes toward their managers or their jobs. These responses among the workers remaining after layoffs, in turn, will affect the workers' performance on the job. Importantly, empirical tests in these studies consistently find significant effects of layoffs on survivors' work performance. However, all existing empirical tests have been conducted in laboratory settings. Here, the empirical research is extended by examining how the productivity of a set of nine manufacturing plants changes in response to layoffs. Unlike the existing laboratory studies, this analysis does not find significant differences in the economic performance of these plants in periods following layoffs.

II. PREVIOUS RESEARCH AND THE EQUITY THEORY FRAMEWORK FOR SURVIVOR REACTIONS

The existing laboratory studies are designed and interpeted within the framework of equity theory developed by Adams.[1] An individual perceives inequity when he "perceives that his job inputs and/or outcomes stand psychologically in an obverse relation to the inputs and outcomes . . ."[2] of those in a relevant reference group. In work organizations, outcomes are broadly defined as pay, benefits, status, and other attributes that can be considered as rewards or compensation for the job.

Inputs are the attributes the employee brings to the employment exchange: human capital traits, demographic characteristics, "and, very importantly, the effort he expends on the job."[3] Much of the empirical research in organizational psychology based on equity theory analyzes what happens to workers who experience "positive inequity"; that is, when an employee perceives that his outcomes-to-inputs ratio exceeds that of relevant coworkers.[4] Traditionally, the outcome-to-input ratio in these laboratory-controlled studies is altered by increasing the compensation of one worker above that of a coworker for continued work on the same task. In the next round of these tasks, the peformance of "overpaid" employees improves relative to that of the coworker and relative to the performance of workers in control groups.[5]

Recently, in an extension of these studies on "positive inequity," attention has focused on the performance of survivors of layoffs. Here, it is suggested that when a coworker is laid off, the survivor may experience positive inequity. Similar to previous results, these laboratory studies document that, after a layoff, the suvivor performs significantly better relative to his previous performance and to the performances of workers in a control group.[6] The interpretation placed on these results is that layoffs primarily arouse guilt or anxiety in the survivor that stimulates improved performance rather than arousing anger (toward the experimenter who laid off the worker) which might stimulate increased performance.

The research on survivors also documents the importance of certain intervening variables on the behavior of survivors. Mechanisms that accentuate the psychological responses of survivors should accentuate performance differentials as well. For example, the method or decision rule for the layoffs may affect behavioral responses. In a study that tests this hypothesis,[7] layoffs were administered in two different ways: (1) by seemingly random selection criteria, and (2) according to previous performance of the workers. When layoffs seemed random, performance increases of survivors were significantly greater than increases of control group workers. However, when layoffs were decided on merit, performance increases of survivors and control group workers were not significantly different.

The growing body of empirical findings from laboratory studies may provide economists with important information on how to model the labor input in the firm's production process. Specifically, these studies suggest that the marginal effect of a decrease in labor may vary according to how the labor input is reduced. For example, the marginal impact of a decrease in labor hours may be different when a worker quits and when a worker is laid off if remaining workers respond differently in these two situations. If the findings in the studies described above do in fact apply to firms in the economy, models of production will require an added degree of complexity. This study, then, is the first to test for the empirical relationship between layoffs and subsequent economic performance with operating data from a sample of firms.

III. PLANT-LEVEL PRODUCTION: SAMPLE, MODEL AND DATA

The sample for this study includes nine paper mills in the same four-digit industrial classification (SIC no. 2621). All are owned by the same parent corporation and all have unionized production workforces. Monthly observations on the operations and layoff experience of these mills cover the period from January 1976 to September 1982. Due to incomplete data, particularly on the number of layoffs, certain monthly observations are not included in the sample. Individual panels on a given mill range from 28 months to 68 months. A full complement of layoff, input, and output data needed to estimate the models below is available for 527 mill-months.

Analyzing changes in workers' economic contribution after layoffs with actual operating data is clearly needed to consider whether the existing set of findings can be extended beyond laboratory settings. However, outside controlled settings, the number of factors other than layoffs that influence the productivity of workers, even in a set of plants in the same four-digit industry, will increase dramatically. Also, with more than one factor of production, the marginal product of employees who remain after a layoff should increase as the ratio of other inputs to labor increases. As a first step in modelling the multivariate determinants of the economic performance of these nine mills, consider a simple Cobb-Douglas production function:[8]

$$Q = A\ K^{\beta_1}\ E^{\beta_2}\ L^{\gamma} \qquad \text{(Equation 1)}$$

where K, E and L are capital, energy and labor inputs. Aware of the inability of standard economic production functions, such as Equation 1, to explain intra- and inter-firm variations in productivity,[9] field investigations of the mills were conducted which led to certain modifications of this function. Generally, limiting the sample to mills in the same four-digit industry classification did not insure homogeneous inputs or output. Before considering how to model the impact of layoffs on the labor input L, this heterogeneity of economic inputs and output will be addressed.

A value-added output measure, the standard price-weighted index used when heterogeneity in output exists, was not available -- nor would it have been appropriate.[10] As an alternative, tons of paper produced is the variable used to measure Q. The heterogeneity in output in this sample is directly associated with differences in departments or stages of the production process. Several dummy variables indicating the presence of various departments that alter the paper products are therefore incorporated in equation 1 as direct controls for output heterogeneity. For example, the difference between sheeted white paper and newsprint corresponds directly to the presence of bleaching and converting departments in mills that produce the former product. The coefficients on such department dummies are expected to be negative as these optional departments use additional labor, capital, and energy inputs to produce a given tonnage of paper. Associated with the vector of production department dummy variables ($\vec{PD}$) is a corresponding vector of department-specific capital value variables ($\vec{KV}$). These more detailed input variables are incorporated in Equation 1 as follows:

$$Q = A(1 + \vec{\alpha}(\vec{PD}))(\vec{KV})^{\vec{\beta}_1} (E)^{\beta_2} (L)^{\gamma} \qquad \text{(Equation 2)}$$

After a logarithmic transformation and rearranging terms, equation (2) can be expressed:[11]

$$\ln Q \cong \ln A + \vec{\alpha}(\vec{PD}) + \vec{\beta}_1(\ln \vec{KV}_1) + \beta_2(\ln E) + \gamma(\ln L) \qquad \text{(Equation 3)}$$

The $\vec{PD}$ variables are constants for any one plant over the seven years for which data are available; therefore they serve as controls for categories of plant-specific effects. To control completely for plant-specific productivity effects, $\vec{PD}$ is expanded in subsequent analyses into a complete set of mill dummy variables. The energy input, E, is defined as total BTU's used in the production process. (The input and output variables are described in greater detail in the Data Appendix. This Appendix also describes the deflators and depreciation schemes used to construct the $\vec{KV}$ variables.) Before describing the specification of the labor input, it should be noted that these unconventional elaborations for specifying inputs and output in this otherwise conventional functional form improve the model of the production process. Specifically, equation (3) accounts for a much larger proportion of production variation in this sample than do more conventional specifications.[12]

To specify the labor input, the statistic available for these plants is similar to statistics often used to measure labor input in other productivity studies: total hourly manhours reported (RL) in monthly payroll calculations. The RL statistic for labor input clearly decreases as layoffs occur by the number of manhours that had previously been worked by the laid-off employees. Moreover, the logarithmic Cobb-Douglas function in equation (3) already allows for the fact that the marginal product of labor will increase as total labor hours decreases according to the product, $\gamma \cdot \Delta\frac{Q}{L}$. However, the research described in Section II suggests that when layoffs decrease the level of labor input, the change in the marginal product of labor may be different from the change in the marginal product of labor that occurs after a similar reduction in manhours that is not the result of a layoff. For example, the workforce may react differently after a layoff than it would after employees quit or after overtime rates decrease. If the empirical findings of the previous laboratory research hold for this sample, layoffs may temporarily produce above average increases in the marginal product of labor as survivors work at above average levels of efficiency.

To allow labor hours to vary in their efficiency, let the true measure of labor input, L, be some variable proportion of the RL statistic according to the equation:

$$L = (1 + \lambda)RL \qquad \text{(Equation 4)}$$

λ is positive when factors cause an hour of labor to be above the average level of efficiency, ceteris paribus. Above-normal work effort on the part of survivors who experience anxiety or guilt in periods after layoffs would, therefore, be associated with positive values of λ.

While the central finding in the existing studies is that survivors will increase their performance, the discussion in these studies allows that decreases in the performance of survivors may occur if a psychological reaction other than anxiety or guilt is the predominant response among remaining workers. For example, angry workers wishing to retaliate against management would lead to negative values of λ, ceteris paribus. To allow layoffs to be associated with changes in the effort and efficiency of survivors, let the layoff rate, LO, provide information on λ. Substituting $\delta \cdot LO$ for λ in equation (4), one obtains:

$$L = (1 + \delta \cdot LO)RL \qquad \text{(Equation 5)}$$

Substituting equation (5) into equation (3) and rearranging terms, one obtains:[13]

$$\ell n\ Q \cong \ell n\ A + \vec{\alpha}(\vec{PD}) + \vec{\beta}_1(\ell n\ \vec{KV}) + \beta_2(\ell n\ E) + \gamma(\ell n\ RL) + \gamma \cdot \delta \cdot LO$$

(Equation 6)

Managers report layoffs in terms of number of employees; therefore, the layoff rate LO is defined as the ratio of the number of production employees laid off in month t to the total number of production employees in month t-1. Since the reported layoffs may not have occurred until late in the given month, the reaction of survivors might not be evident until the month after the layoff. The equation (6) model then will also be estimated with a lagged layoff rate variable. If survivor reactions are indicated by the coefficients on these layoff rate variables, the change in labor efficiency may only be temporary. To be able to track whether any initial survivor reaction dissipates over time, the empirical specification will be expanded to examine changes in the labor productivity during the first one-half year after a layoff. That is, output is specified as a function of the layoff rate in the current month and the layoff rates in the six previous months as well. Accordingly, this specification can be written:

$$\ln Q_t \cong \ln A + \vec{\alpha}(\vec{PD}_t) + \vec{\beta}_1(\ln \vec{KV}_t)$$

$$+ \beta_2(\ln E_t) + \gamma(\ln RL_t)$$

$$+ \sum_{i=0}^{6} \mu_{t-i} LO_{t-i}$$

(Equation 7)

As in equation (6), $\mu_{t-i} = \gamma \cdot \delta_{t-i}$. The differential impact of layoffs on output in period t as a method to reduce manhours will be given by: $\gamma[\delta_t LO_t + \delta_{t-1}LO_{t-1} + \ldots \delta_{t-6}LO_{t-6}]$. Similarly, the cumulative effect over six months of a layoff in period t on output relative to a similar decrease in manhours that occurs for other reasons will be given by: $\gamma LO_t[\delta_t + \delta_{t-1} \ldots \delta_{t-6}]$. In equation (6) or (7), values of δ can be isolated by dividing the coefficient on a given layoff rate variable by the coefficient on the RL variable. The semi-logarithmic specifications in equations (6) and (7), then, are used to estimate the relationship between layoff rates and subsequent productivity changes.[14] If survivors are spurred to above average levels of efficiency, then the coefficient(s) on the layoff rate variable(s) should be positive (assuming a positive coefficient on the RL variable). If reactions which hinder performance, such as anger toward management, are the dominant responses among survivors, the coefficient(s) on the layoff rate variable(s) should be negative. To see whether layoffs do in fact lead to different changes in productivity than do other fluctuations in manhours, estimates from the production equations are now presented.

IV. EMPIRICAL ESTIMATES OF THE RELATIONSHIP OF PRODUCTIVITY TO PRIOR LAYOFFS

When equation (6) is estimated, the coefficients presented in Table (1) are obtained. Column (1) presents estimates obtained when equation (6) includes only the layoff rate of the current period. Column (2) replicates the column (1) specification except that the dummy variables for the presence of certain production departments (the $\vec{PD}$ variables) are replaced by a complete set of eight plant dummy variables. In neither specification is the coefficient on the layoff rate significantly different from zero. Also, in both the column (1) and (2) specifcations, the coefficient on the RL variable, γ, is approximately .7. The ratio of the layoff coefficient to the RL coefficient, which yields the estimate of δ, is also judged not to be significantly different from zero.[15]

When the column (1) and column (2) specifications are expanded to include six periods of lagged layoff rate variables, the coefficients in columns (3) and (4) are obtained. Not one coefficient is significantly different from zero at the .10 level. As judged by an F-test comparing the column (3) and (4) models to similar models without any layoff rate variables for the same N = 481 sample,[16] the entire complement of layoff rate variables does not add to the explanatory power of the models. The coefficient on the layoff rate lagged one period in the column (4) specification has a p-value that is just greater than .10; however, when the layoff rate variables are added to the model, other coefficients in the model have lower levels of significance. As a result, even in this specification, the layoff rate variables do not improve the model significantly.

As described in Section II, an important theme in previous research is the importance of intervening variables that might mediate the effects of survivors' reactions.[17] While these studies have only documented increases in performance after layoffs, they do suggest that decreases in performance may also be possible. It might therefore be argued that the insignificant coefficients on the layoff rate variables in Table 1 simply reflect the fact that layoffs in certain mills may lead to strong positive effects on survivors' effort and efficiency, while in others the effects may be negative because the mills are subject to different intervening variables. To test for this possibility, equations are estimated separately for each mill. Coefficients on the layoff rate and lagged layoff rate variables from these nine mill-specific equations are presented in Table (2).

Among all coefficients, very few are significantly different from zero. In the case of mill 5 in which two of the seven layoff rate coefficients are significantly different from zero, one is positive (line 2a) and the other negative (line 2d). Mill 1 does exhibit a clear pattern of negative coefficients, but this set of variables does not add to the explanatory power of the model without any layoff rate variables. Mill 9, on the other hand, exhibits a consistent pattern of positive coefficients, but only one coefficient (for the layoff rate lagged five periods) is significantly different from zero. Despite the significant coefficient, the model is not improved significantly by the set of layoff rate variables since the significance levels of other coefficients in the model decline when the layoff variables are added. Moreover, one would have expected the strongest survivor effects in the month of the layoff or the first month after the layoff -- not after a lag of five months. Taken as a whole, the empirical results for the whole sample in Table 1 or for each mill individually in Table 2 provide no evidence that the change in productivity after a layoff is different from the changes that occur after similar decreases in employment that are not the result of layoffs.

Table 1: The Effect of Prior Layoffs on Productivity[a]

	(1)	(2)	(3)	(4)
obsevations	527	527	481	481
1. layoff rate	-.013 (.200)	-.104 (.189)	.003 (.200)	-.099 (.189)
2. lagged layoff rates				
(a) one period	--	--	-.173 (.197)	-.305 (.186)
(b) two periods	--	--	.058 (.196)	-.051 (.186)
(c) three periods	--	--	.102 (.196)	-.023 (.185)
(d) four periods	--	--	.152 (.194)	.034 (.183)
(e) five periods	--	--	.255 (.195)	.153 (.183)
(f) six periods	--	--	.264 (.195)	.172 (.183)
3. Other Controls	b	c	b	c
R^2	.940	.947	.945	.951

a - Standard errors in parentheses
b - Other controls include those specified in equation (6). Detailed descriptions of these controls are presented in the Data Appendix.
c - Controls are the same as those in note b, except the PD controls for the presence or absence of certain production departments is replaced by a complete set of eight mill dummies.

V. DISCUSSION AND IMPLICATIONS

The results of this study clearly indicate that the empirical findings in previous laboratory studies do not necessarily describe the experience inside actual firms. On the other hand, this study considers the relationship between layoffs and subsequent productivity in only nine establishments. It does not change the validity of the results obtained in controlled experimental settings. To understand the difference between the results obtained in this study and those in the studies described in Section II, field investigations of the mills and interviews with managers were conducted.

In field investigations, the continuous flow production process in these paper mills was observed to be highly capital-intensive[18] and machine-paced. Even if strong worker reaction effects (of anxiety, guilt, or anger) were engendered in response to layoffs, such a technology may severely limit the degree to which any changes in effort or attention on the part of survivors affect productivity. That is, in such a capital-intensive setting, attendance of workers may be more critical than changes in effort or attention of the workers.

Also described in Section II, one laboratory study suggests that the decision rule used for layoffs mediate the impact of layoffs on survivor performance. Layoffs based on merit did not produce a significant change in survivors' performance, while layoffs decided by a seemingly random decision did. As described by managers in interviews, the contractual provisions governing layoffs in these nine unionized mills all rely heavily on strict seniority systems. While this is clearly not a random or merit-based system, it might reasonably be argued that a seniority-based decision rule for layoffs would reduce the types of reactions in

Table 2: Estimates of the Effect of Prior Layoffs on Productivity from Individual Plant Equations[a]

plant #	1	2	3	4	5	6	7	8	9
observations	28	64	51	46	50	68	46	63	65
1. layoff rate	-3.063 (3.359)	.415 (.434)	2.523 (2.458)	-1.302 (2.235)	.565 (14.378)	.297 (1.293)	-7.114 (25.234)	.253 (.241)	.718 (1.017)
2. lagged layoff rates									
(a) one period	-.558 (5.534)	.336 (.474)	-1.603 (2.487)	2.99 (2.157)	37.979* (20.209)	.412 (1.269)	16.283 (25.949)	-.208 (.177)	.324 (.966)
(b) two periods	-2.484 (5.206)	.672 (.501)	-5.076* (2.556)	2.788 (2.153)	-22.520 (15.861)	.089 (1.334)	30.555 (26.233)	.026 (.189)	1.393 (1.089)
(c) three periods	-1.019 (5.688)	.714 (.474)	-2.674 (1.649)	3.646 (2.327)	-3.463 (12.681)	.342 (1.314)	-25.615 (24.971)	-.044 (.183)	.789 (.977)
(d) four periods	-.412 (3.318)	.482 (.480)	-3.116* (1.685)	3.728 (2.196)	-20.340* (10.954)	-.872 (.861)	6.594 (23.886)	.146 (.189)	1.249 (1.049)
(e) five periods	-2.036 (3.311)	-.064 (.488)	.586 (1.688)	2.721 (2.136)	.597 (6.305)	-.025 (.852)	13.575 (23.472)	.245 (1.84)	2.058* (.943)
(f) six periods	-.805 (8.281)	.682 (.521)	-1.689 (1.533)	1.834 (2.172)	9.488 (6.307)	-.968 (.831)	11.569 (22.279)	.146 (1.85)	1.142 (.914)
3. Other Controls	b	b	b	b	b	b	b	b	b
R^2	.881	.459	.759	.758	.812	.958	.968	.864	.828

a - Standard errors in parentheses.
b - Control variables are those in equation (6) that are defined for individual plant equations. Dummy variables for the presence or absence of certain production departments (PD) drop out of invididual plant equations.
* - Significant at the .10-level, two-tailed test.

survivors that would lead to changes in their effort or performance. First, anxiety would probably not be engendered by the layoffs, since there would be little uncertainty about who would be laid off next. Even for the more junior workers at greater risk after the layoff, there may not be an increase in effort since these workers have little control over their fate. Furthermore, since the employees' representatives took part in developing the contractual decision rule for layoffs, survivors may be less likely to experience either guilt or anger.

While this study takes an important first step in moving the empirical study from laboratory settings to settings of existing work organizations, these final considerations point out the kinds of field research that provide further insights. Specifically, investigation of the layoff-productivity relationship in nonunion settings and particularly in organizations where decision rules other than seniority-based systems are in effect may produce very different results than those obtained in this study. Research in these settings may also help to reconcile the results of this study with those obtained in the previous laboratory research.

DATA APPENDIX: Descriptions and Definitions of Output, Input and Layoff Rate Variables

Class of Variable (Variable Symbol)	Definition of Measure Used
1. Output (Q)	Tons of Paper Produced
2. Production Departments Present in the Mills ($\vec{PD}$)	Mills with different combinations of production departments produce different types of final paper products. Dummy variables are included for the presence of: a pulping department; a bleaching and dyeing department; a converting department (either sheeting or coating operations); and a set of variables for whether the mill has two, three, four or five or more paper machine departments.
3. Department-specific value of capital ($\vec{KV}$)	Total depreciated, deflated value of assets in each department in the mills. The depreciation schedule is the one used by the mills' management -- a straight-line depreciation applied over engineering estimates of the assets' expected life. The deflators used are capital price indices in *Economic Report of the President* (Washington, D.C.: U.S. Government Printing Office, 1981), p. 229. Table B-57, "Producer Price Indexes for Major Commodity Groups -- Machinery and Equipment". In addition to the production departments that are present in some mills and absent in others, as listed in line 2 above, the following departments are present in all mills: wrapping and shipping; energy generation; pollution and recycling; and buildings not elsewhere classified. Each department has a total value of capital variable calculated for it.
4. Energy (E)	Total BTU's of energy consumed in production at the mill
5. Labor (L)	Production Workforce Manhours as reported in Monthly Payroll Calculations
6. Layoff Rate (LO)	Each of the nine mill managers made available confidential copies of U.S. Department of Labor's "Monthly Report on Labor Turnover." A layoff statistic (distinct from other sorts of separations) is reported for each month. Since this statistic is reported in units of employees, the layoff rate is the ratio of production employees laid off in month t to the total number of production employees in the previous month.

FOOTNOTES

[1]Adams, J. Stacy. "Toward an Understanding of Inequity," in Gary A. Yukl and Kenneth N. Wexley, eds., Readings in Organizational and Industrial Psychology (London: Oxford University Press, 1971), pp. 194-210.

[2]Ibid., p. 197.

[3]Ibid., p. 195.

[4]Mowday, R., "Equity Theory Predictions of Behavior in Organizations," in R. M. Steers and L. W. Porter (eds.), Motivation and Work Behavior (New York: MacGraw-Hill, 1979), pp. 124-126.

[5]For a review of relevant "equity theory" studies, see Walster, Elaine, G. W. Walster, and Ellen Berscherd. Equity Theory and Research (Boston: Allyn and Bacon, 1970), pp. 114-142.

[6]Brockner, J., J. Davy, and C. Carter, "Layoffs, Self-Esteem and Survivor Guilt: Motivational, Attitudinal and Affective Consequences," in Organizational Behavior and Human Decision Processes (forthcoming); J. Brockner, J. Greenberg, A. Brockner, J. Bortz, J. Davy, and C. Carter, "Layoffs, Equity Theory, and Work Performance: Further Evidence of the Impact of Survivor Guilt," Academy of Management Journal (forthcoming); and J. Brockner, M. O'Malley, S. Grover, N. Esaki, M. Glynn, and S. Lazarides, "The Effects of Layoffs, Job Insecurity, and Self-Esteem on Survivors' Work Performance and Attitudes," Columbia University, unpublished manuscript.

[7]See Brockner, O'Malley, et al.

[8]It is possible that even if the individual mill's technology has fixed factor characteristics that cannot be characterized by the relatively smooth Cobb-Douglas function, data across plants with different

types of fixed-factor input configurations may map out a "smoother" function.

[9]For one statement of this position, see Nelson, Richard R., "Research on Productivity Growth and Differences: Dead Ends and New Departures," Journal of Economic Literature, Vol. 19, No. 3 (September, 1981), pp. 1029-1064.

[10]Specifically, a value added index is based on price weighting assuming competitive prices. These mills are often sole or principal employers in rural regions enjoying a large degree of monopsony power. While the unions may counteract this power and introduce a case of bilateral monopoly, it would appear unreasonable to assume competitive prices for labor (and possibly other inputs as well).

[11]The equation 3 transformation uses the approximation $\ell n(1 + x) \cong x$ for x small.

[12]Equation 3, with L specified as total production manhours reported in monthly payroll calculations, accounts for over 95% of the total variation in production in this sample. In contrast, a ℓn-transformation of the Cobb-Douglas function in equation (1), with capital measured as a mill's aggregate net investment, accounts for only 65% of the output variation. While all the coefficients in the equation (3) model are significant with the expected signs, the equation (1) model produces several nonsensical coefficients. Specifically, the coefficient on capital is negative for this sample in which capital plays a central role in transforming raw materials into final output.

[13]Equation 6 again employs the ℓn-transformation approximation described in footnote 11.

[14]One final specification issue is that department-specific KV variables will equal zero when the mill in question does not have that department (i.e., the corresponding PD variable equals zero). The equations estimated and reported in Sections IV and V specify KV in dollar units instead of ℓn-dollar units. An alternative approach is to add a small positive value to KV variables that are equal to zero. The alternative specification does not affect the coefficients of interest reported in the tables in this study to any appreciable extent.

[15]The significance of the ratio of two normally distributed quantities is judged by Fieller's method. For a description of this method, see Maddala, G. S., Econometrics (New York: McGraw-Hill, 1977), pp. 101-102.

[16]The F-statistic used to compare the two models is given by:

$$\frac{(SSR_R - SSR_U)/(df_R - df_U)}{SSR_R/df_R}$$

where SSR refers to the sum of squared residuals, df to degrees of freedom, and the subscripts R and U to the restricted model without layoff variables and the unrestricted model with layoff variable.

[17]See Brockner, O'Malley, et al.

[18]Using 1976 industry-level statistics, only 29 out of four hundred and fifty four-digit manufacturing industries were more capital intensive than SIC #2621 as judged by the ratio of the value of plant, machinery, and equipment per production employee. U.S. Bureau of the Census, Annual Survey of Manufacturers.