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The Effect of Human Resource Practice on Quit Rates

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Abstract

We make use of a unique data set from a 2003 telephone survey of a random sample of 125 small manufacturing firms located in southeastern Pennsylvania to test for the influence of human resource management practices on the establishment quit rates. The literature on high performance work systems suggests that selection. training, involvement and empowerment policies can influence worker attitudes and commitment in a way that enhances organizational performance. Our results indicate that quit rates are lower in firms where workers have some degree of control over the pace but not the method of work, where workers use computers in a broad array of tasks, where there is a high degree of information sharing and where a high percentage of the firm's budget is spent on job-related training provided through formal means. Quit rates are significantly higher in establishments where managerial operational goals are oriented toward cost containment and where there is a high degree of general training. Frequent worker-management meetings on technology and production issues and the existence of performance-contingent pay systems are not related to the firm's quit rate in this sample.

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JEL Codes: M12, J41, J53, J63

Key Terms: Quit rates, human resource policies, high performance work systems

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Introduction

An appealing result from one stream of research in the human resource management (HRM) and labor economics literatures is the notion that business firms can achieve significant performance enhancements from implementing enlightened HRM practices. A combination of programs entailing intensive applicant screening, training, worker self-management and effective participation in teams, information sharing, profit- and gain-sharing and work organization innovations designed to empower workers now forms the basis for identifying the presence of a high-performance work system. While many scholars and practitioners refer to these high-performance work systems as “best practice” HRM systems (Lewin 2001), the empirical basis for this conclusion is not as firm as one might desire.

Most empirical studies of the impact of different HRM practices on organizations pay particular attention to employee turnover. In part this is because the objective nature of turnover data in comparison with responses to attitude surveys. But this also reflects the hypothesis first developed by Hirschman that workers face a tradeoff between leaving a firm and using available mechanisms within the firm to influence policy in the face of significant problems. High-performance work systems can have a positive effect on firm outcomes by providing an effective voice mechanism. This will deter exit by skilled workers with grievances in addition to allowing the firm to tap into worker knowledge in evaluating process improvements. But a brief review of studies of the effect of high-performance HRM systems on worker turnover reveals very mixed results.[1]

One group of studies relies on aggregate, additive indexes measuring the number, and sometimes the extent of coverage, of high-performance practices adopted by an

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[1] Studies have also examined the effect of HRM practices on productivity and financial performance. The recent review of this literature by Goddard (2004) suggests a similar conclusion regarding the effect of high-performance work systems on these measures of organizational performance.

organization. Huselid (1995) uses aggregate indexes of worker skills and organizational structure and worker motivation and finds both to be negatively related to employee turnover albeit at low levels of statistical significance. Batt (2002) and Guest et.al. (2003) report regression results with statistically significant negative relationships between an HR index and worker quit rates. However, MacDuffie (1995) and Guthrie (2001) find significant positive coefficients on HR indexes in turnover regressions.

These aggregate indexes have been criticized by some (see Shaw et.al. 1998) because the additive approach to their construction does not allow for the assumed interaction effects of different practices that is the main rationales for their use. Additionally, the use of an aggregate index does not permit the isolation of key HR practices. Finally there are no guiding principles for the practices that should be included in an HR index, making comparisons across studies -- that are typically taking advantage of available data -- very difficult.

Other empirical studies attempt to estimate the independent relationship between worker turnover and individual work practices that are included in the cluster of practices falling under the high-performance rubric. These have yielded varying results. For example, Cappelli and Neumark (2004) find that meetings, self-managed teams, job rotation systems, and profit-sharing compensation plans were all negatively related to the quit rate in manufacturing firms but positively related to the quit rate in non-manufacturing firms. And while Batt (2002) and Batt et.al. (2002) find that worker participation in problem solving committees is associated with a lower quit rate, Wilson and Peele (1991) and Lincoln and Kalleberg (1996) find no statistical association between quit rates and worker participation schemes in their samples.

A problem with assessing and comparing studies in this vein is that rarely do they have data on the full array of potential high-performance work practices in the sampled firms. This raises the possibility of omitted variables bias in the relationships that can be estimated (Goddard 2004). Additionally, it may also be necessary to control for the use of low-involvement work practices when estimating the effect of high-performance systems. Lewin (2001) has shown that many firms have simultaneously deployed high-performance systems for core employees and low-involvement, cost-containment systems for peripheral employees over the past two decades. His results and those of Batt et.al. (2002) indicate that the latter types of HR practices have significant positive effects on quit rates, controlling for the presence of high-performance practices in the firm.

This paper contributes some additional empirical findings on the relationship between HR practices and worker quit rates in a sample of small to medium manufacturing firms operating in a limited number of industries and located in eastern Pennsylvania. This data set, described in detail in the next section, has three advantages for this purpose. First, while restricting the scope of the sample might limit the general applicability of our results, it also has the advantage of yielding data on a relatively homogeneous group of business firms. Second, the survey of HR practices employed by these firms covers a wide array of practices linked in the literature to high-performance systems. We are missing data only for the hiring, screening and selection practices of the sample firms. Third, we can control for the relative importance of cost-containment managerial objectives for the sampled establishments.

The Data

We use a unique data set from a 2003 telephone survey of a random sample of 125 small manufacturing establishments in southeastern Pennsylvania by Gallardo L.

(2003). The purpose of this survey was to study complementarities among HRM and organizational practices in the implementation of advanced manufacturing technologies. Gallardo L. (2003) has a detailed discussion of the methodology.

The target population included establishments with fewer than 250 employees in nine 2-digit SIC manufacturing industries likely to implement computer-aided design and manufacturing (CAD/CAM) technologies: 25-Furniture & Fixtures; 30-Rubber & Misc. Plastic Products; 33-Primary Metal Industries; 34-Fabricated Metal Products, except Machinery & Transportation; 35-Industrial & Commercial Machinery & Computer Equipment; 36-Electronic & Other Electrical Equipment & Components, except Computer Equipment; 37-Transportation Equipment; 38-Measuring, Analyzing & Controlling Instruments, Photographic, Medical & Optical Goods, Watches & Clocks; 39-Misc. Manufacturing Industries.

The population included all known manufacturing establishments with fewer than 250 employees in these industries in the greater Philadelphia and the Lehigh Valley (Bucks, Chester, Delaware, Lehigh, Montgomery, Northampton and Philadelphia counties). This population was identified through what we believe are the most comprehensive lists available in the region: the Delaware Valley Industrial Resource Center (DVIRC) establishment database for Philadelphia and neighboring counties; Lehigh University's Manufacturing Resource Center establishment database for the Allentown-Bethlehem-Easton region; and Dun & Bradstreet's establishment universe for the region.

From this population, 711 establishments were randomly selected, sent an introductory letter, and contacted by phone to request participation in the study. Of those, 513 (72.2%) were established as good contact addresses and working telephone numbers. From these 513 good contacts, 130 establishments completed telephone surveys, a response rate of 25.3%. Five of these were later eliminated because either the survey was incomplete or the establishment had more than 250 employees, resulting in a final sample size of 125.

The individuals responding to the telephone survey were the owner, president, operations manager or someone in an equivalent function. Questions probed six principal areas: 1) establishment profile, including employment, turnover and type of operations; 2) the sources of knowledge used by the firm and employees; 3) design and manufacturing technologies used; 4) management's operational goals and extent of the accomplishment of those goals; 5) workforce training investment and methods; 6) other HRM and organizational practices.

The Model and Variables

We use stochastic specifications using both ordinary least-squares regression (OLS) and Tobit censored-normal maximum-likelihood estimation techniques (Tobin, 1958) to model the annual establishment-level quit rate as the dependent variable:

$$\text{Quit rate} = a + \Sigma\, b_i\, X_i$$

Our independent variables (Xi) control for possible inter-establishment, inter-industry, inter-labor market differences, and then include the managerial choice variables related to HRM practices. We use the Tobit specification because quit rates are left-truncated at zero: 39 of our 125 establishments reported zero voluntary quits. We also report OLS results for comparative purposes and in particular because coefficient and goodness-of-fit measures are more familiar and interpretable. As we show in more detail below, the qualitative results are encouragingly stable with respect to specification.

Table 1 shows the means, standard deviations and ranges of all variables used in our econometric modeling. Our dependent variable is the establishment's voluntary quit rate, calculated using the reported number of employees who voluntarily left during the previous year, divided by the reported total employment. These are based on the two questions: "How many workers are employed at this location?" and "How many workers have voluntarily left this location in the past year?"

We use a series of establishment-level, industry-level, and county-level control variables. Establishment-level controls include:

- The age in years of the establishment in 2003, derived from the question: "In what year did your company start operating?"
- A proxy for establishment size, the scale of manufacturing operations in square feet (natural log), based on the question: "What is the total square footage of this location dedicated to manufacturing?"
- The percentage of total employment in two employment groups: 1) managerial or professional occupations and 2) blue-collar workers. We constructed these by adding the responses to the question "Approximately what percentage of jobs at this location are in each of the following categories? For the first group we added the percentages reported for "Managers and Supervisors" and "Non-managerial professionals". For the second we summed "Unskilled blue-collar workers" and "Skilled blue-collar workers". Other possible responses include "Clerical workers" and "Others."

- An estimate for the employees' average years of education. We constructed this variable from the following question: "Please tell me what percentage of ALL workers in this location has the following levels of education. I will read the levels of education first and then ask you the percentage of each. Graduate Degree, Completed 4-year college; Some College or Technical School; High school; Less than a high-school education." To estimate the average, we multiplied the reported percentages by 18 years for graduate degree, 16 for college, 14 for some college or technical school, 12 for high school, and 10 for less than high school. So, this estimate ignores kindergarten and approximates average graduate degrees at 2 years and average school dropouts to occur 2 years prior to high-school completion.
- A measure of product diversity and manufacturing flexibility, based on the response to "How many different products did you make over the past year."
- A dummy variable capturing whether or not the establishment is a defense prime or subcontractor, constructed from positive responses to either of two yes-no questions: "Are any of the products manufactured at your location shipped directly to Federal Defense Agencies, such as the Department of Defense, Army, Navy, Air Force, Marine Corps, or the Defense Logistics Agency?" and "Are any of the products manufactured at your location shipped to other companies or divisions of companies that are prime contractors to any of the Federal Defense Agencies?" These questions are identical to those used in defense contracting studies by the Bureau of the Census (e.g. 1989) and Kelley and Watkins (1995, 2001).

For industry-level controls across the nine 2-digit SIC industries, we include six dummy variables. We combined SIC 25 and 37 because so few responding establishments were in either. The base case is also a combined miscellaneous category, SIC 38-39.

The final pair of control variables captures characteristics of the labor market. We include the percentage unemployment rate in the establishment's county, and the average weekly wage of workers covered by the Pennsylvania Employment Security Law (natural log) in the establishment's 3-digit SIC industry in their county. The source for these two variables was the PA Labor market Information Database System, which can be accessed at www.palmids.state.pa.us.

Moving to the human resource practices and employee voice variables of central interest, we include five sets of variables the HRM literature suggests are likely to help predict establishment-level quit rates: 1) the orientation of management's strategic operational goals, whether cost-cutting, quality-oriented or product-differentiation; 2) worker involvement in decision-making; 3) collaborative information sharing among management and workers generally and particularly related to production technology implementation; 4) the extent, types and methods of worker training; and 5) performance incentive available to workers. Because we had multiple indicators for a number of these variables, we constructed indexes or principal factors that combine several related metrics.

Three variables capture the nature of management's strategic orientation. These are the three highest-eigenvalue common factors that resulted from a factor analysis of the importance the respondent gave to thirteen related measures. The underlying measures were responses to the following question: "Next, I am going to talk about some typical manufacturing operational goals. For each of these goals, please rate each goal from 1 to 5, 1 being not important to 5 being extremely important."

The wording of the 13 various specific goals listed in the question and three retained orthogonal principal factors from the factor analysis, together with their Kaiser varimax-rotated (Kaiser, 1958) factor loading are shown in Table 2. We highlight in bold the highest loadings for each factor. We interpret Factor 1 as a quality and performance orientation. It loads positively on defects, quality improvement, rework, lead time, process flexibility and competitive advantage. Factor 2 we interpret as a cost-reduction orientation, because it loads on increasing productivity, reducing product cost and reducing direct labor costs. Factor 3 seems to be a propensity towards a product differentiation strategy, loading on product development lead times, product variety and the integration of design and manufacturing. None of the other four factors with positive eigenvalues had proportions greater than 10 percent, and it was difficult to discern interpretable managerial orientations in their factor loadings.

The next set of two variables encompasses the extent to which workers have significant decision-making responsibilities, one for decisions about the pace of work, the second for decisions about work methods. We created separate indexes based on coded 1 to 5 scale responses to each of the following questions: 1) "Who sets the pace of work at this location? Exclusively managers; Mostly managers; Equally managers and workers; Mostly workers; Exclusively workers" and 2) "Who decides how the tasks should be accomplished?" The standard score index variables used in the modeling are the establishment's difference from the mean response divided by the standard deviation.

The third set under investigation involves four variables related to information sharing and collaboration among managers and workers. One is a single principal-factor variable constructed from four related responses. The question was "How accessible would you say are the following types of information to all the workers in your company? Accessibility means that either the information is presented to the workers or posted, or that the workers have access if they request it. Please rate from 1 to 5, 1 being not accessible to 5 being fully accessible. A) General financial status of the company; B) Financial information about products costs and profit levels; C) Production related information such as production goals, quality levels, etc.; D) Location's strategic plans." The factor analysis is reported in Table 3. There was no clear loading pattern in the resulting principal factors, and the eigenvalues fell dramatically after the first factor. Since it loaded across all four initial variables, we interpret this single factor as management's propensity to share strategic and performance information with workers.

Because of the goals of the original study for which this data was collected, there were also several questions primarily related to the implementation of advanced manufacturing technologies. These included "Has this location established committees made up of both blue-collar workers and managers who meet regularly to deal with company issues?" Among those who said yes, they were asked "How regularly would you say that these committees meet to address the following issues? Please rate them from 1 to 5, 1 being rarely to 5 being constantly. A) The planning of new technology; B) The implementation of new technology; C) Other production related issues." If the establishment did not have these committees, we coded a zero. In our empirical modeling we tried several constructions of these responses, and the most robust, stable and best-fitting specification combined A and B,. We added the responses to A and B together into a single metric measuring the frequency of two types of meetings about planning or implementing new technology. We then developed two separate standard score index variables, one for the combined new technology meetings, and a second for meetings on other production issues.

The frequency of meetings on new technology is obviously correlated with whether the firm is using these new technologies, so we also include a variable for the breadth of computer use across the establishment. The question here was "For the next series of questions, please answer by rating your use of computers within the company from 1-5. Answer 1 if your company does not use them for that purpose and 5 if they always use them. Does your company use computers for: A) Parts or product design; B) Process planning, scheduling or monitoring; C) Quality assurance; D) Materials or parts planning; E) Automation of other production processes; F) Exchange data with suppliers or customers?. To capture breadth, rather than depth in a single area, we combined these six types of uses of computers in manufacturing into a single breadth index by counting how many of the six the respondent answered 3 or above. We then converted this 0 to 6 index into a standard score for use in the modeling.

Turning now to the fourth set of HRM study variables, we include four metrics associated with workforce training practices. To capture the degree of overall emphasis on training, the first is the response to a direct question about the percentage of the establishment's total budget that is invested in work-related training, which we use as a measure of skill-specific training provided by the employer.

The next variable aims to capture establishment differences in employer-provided training for general skills related to effective participation in problem-solving committees and worker self-management. We use the response to a direct question about the number of "workers whose main job responsibility is associated with the design and/or manufacturing of this location's products" who over the past 12 months "received training organized and paid for by your company in professional skills such as effective communication skills, how to be an effective team member, and problem solving techniques? Training includes classroom training, or courses or seminars apart from regular work activities." We divided this response by the establishment's total number of employees, and use this ratio in our modeling.

The remaining two variables in this set of training variables are factors constructed from a series of questions about training sources for these same production workers. The survey asked about training in four different types of skills: 1) "Fundamental skills such as basic mathematics, basic English, basic use of computers;" 2) Professional skills as noted above; 3) "Manufacturing foundation skills such as fundamentals of manufacturing, manufacturing processes, production control, quality assurance, modern manufacturing methods, geometric dimensioning and tolerancing;" 4) CAD/CAM-related skills: blue print reading, technical drafting, computer aided design, computer aided manufacturing." The training source questions asked "Who has been the main training provider: A) State, federal or local government-funded agencies; B) Vendors or distributors; C) Business-industry association; D) Local academic institution; E) Formal in-house training by peers or supervisors; F) Informal in-house mentoring sessions; G) other provider?" Responses were yes-no. Thus, we have dummy variables on seven possible training sources for each of four training types.

To capture differences in the relative emphasis on training sources, we performed a factor analyses across the 28 types of training source-type dummies. Three categories had zero positive responses, and were dropped. Table 4 shows the remaining 25 dummy variables, and the Kaiser varimax rotated factor loadings for the highest two eigenvalue factors. Beyond these two factors, we again found no clear interpretation of the factors, while these top two factors were, we believe, a conceptually useful and interpretable summary of this complex set of variables. The first factor clearly loads on in-house approaches to training, with positive loadings for informal mentoring and negative loading for formal in-house approaches. So, we interpret this factor as the tendency to rely on informal-in-house mentoring. The second factor is consistently negatively loaded on in-house or "other" approaches, and has high positive loadings on the range of various non-academic external sources of training, such as vendors, industry associations and government-funded agencies. So, we interpret this factor as the propensity to rely on external professional training sources. We had expected more factors to emerge, such as one pointing to emphasis on academics or to government sources, or preferences for generic vs. manufacturing specific skills emphasis, but could not discern reasonably interpretable loading patterns beyond these two factors.

The final set of two variables includes dummies for two types of incentive programs available to workers. One question asked "Are any of the following incentives available at your location? A) Profit sharing; B) Employee stock ownership plan; C) Performance-based bonuses." For each type the respondent was asked who was eligible, from (1) exclusively managers, to (3) equally managers to (5) exclusively workers. Since these establishments were all small (fewer than 250 employees) very few had stock ownership plans. We therefore combined A & B into a single dummy variable for whether or not the establishment made available to workers either profit sharing or stock ownership plans. The second variable is a dummy for whether performance based bonuses are available to non-managerial employees.

Results

Table 5 presents the coefficient estimates, standard errors and two-tailed t tests for the independent variables in our quit rate model using both the Tobit and ordinary least squares (OLS) estimators. The first two columns include only the control variables and the last two add the results for the full model, including the HRM variables. The model seems to do reasonably well in explaining inter-establishment quit rates in our sample. The full model is able to account for 44% of the variation in quits across these establishments.

While the control variables considered as a group have a statistically significant relationship with the establishment quit rate, only the dummy variable for establishments that were defense contractors was individually significant at the five percent level. The indications are that defense contractors had employee quite rates that were substantially lower than quit rates among non-contractors. This could be because defense contractors pay higher wages, have more stable employment prospects, or provide more specific training than other manufacturers, thereby providing incentives for workers to retain their jobs. The lower quit rate evident for defense contractors may also reflect better management skills required in organizations able to successfully compete for and comply with defense contracts. The fact that the coefficient on the defense dummy variable in our regressions is substantially lower in both size and significance when the array of HRM variables is included suggests some support for the idea that defense contractors are more likely to follow managerial practices that lead to lower quit rates.

If we concentrate our attention on the full-model Tobit results, two other statistically significant control variable results emerge. Quit rates are significantly higher in larger manufacturing establishments and significantly lower in establishments in the industrial and commercial machinery and computer equipment industry.

Among the operational goal orientation variables, the factor oriented toward cost-containment objectives has a statistically significant positive effect (at the 10 percent level) on the establishment quit rate. This is as expected, since this managerial orientation is likely to be associated with wage restraint and greater use of outsourcing and contingent employment, reducing job security for current employees (Lewin 2001 and Batt et.al. 2002). The quality and product differentiation goal orientations do not appear to be related to the quit rate in our sample.

The quit rate is substantially lower in establishments where workers have some control over decisions about the pace of work. This is consistent with the hypothesis that worker self-management practices have a positive return to the firm. Interestingly, worker control over work methods is positively related to the establishment quit rate, although this coefficient is statistically significant at just the 10 percent level. At first glance these two estimates appear contradictory. However, as Goddard (2001) points out, the relationship between worker job satisfaction and the responsibilities of worker self-management is likely to be non-linear, with added responsibility at some point associated with a more stressful work setting. It may be that stress is indeed higher for workers with responsibility for decisions about work methods and lower for those with control over work pace.

Turning to the next group of HRM variables, the quit rate is significantly lower in establishments with the broadest degree of computer use. Since several studies have identified a positive link between computer use and worker compensation, this link might be operative in the connection between computer use and quits in our sample. The quit rate is also significantly negatively related (at the ten percent level) with the factor indicating a high degree of information-sharing on the financial and operational performance of the establishment. Preuss (2003) argues that the quality of information sharing mediates the way in which employee knowledge, work design and teams and committees affect organizational performance. However, the variables measuring the frequency and existence of worker-management meetings on new technologies and production issues are not significantly different from zero in our sample.

The training measures available in our sample also yield some interesting results. The quit rate is significantly lower in establishments spending a higher percentage of budgeted funds on work-related training. On the other hand, quit rates are significantly higher in establishments with a higher percentage of workers trained in the previous year in communication and team problem-solving skills. These two results are what we would expect from specific training that enhances the value of the worker mainly to the current employer and general training that imparts skills useful at any employer. The factor that indicates the firm's reliance on informal, in-house mentoring as the means of providing training has a significantly positive relationship with the establishment quit rate. This result is consistent with the finding of Fairris (2004) that off-the-job, formal methods of training are related to lower quit rates. The results for our factor indicating a reliance on external training providers suggests that this source of training is unrelated to the establishment quit rate.

Finally, the existence of profit-sharing, stock ownership, and/or performance bonus plans available to workers did not have a statistically significant effect on the establishment quit rate. One could argue that the effect of contingent pay on aggregate quit rates is ambiguous and dependent on the mix of employees. Contingent pay plans are likely to increase the likelihood that a below-average performer would leave the firm since his compensation is likely to be low under such a plan.

Conclusion

The general conclusion from this study of 125 manufacturing firms located in eastern Pennsylvania is that human resource management practices can result in enhanced worker satisfaction and commitment resulting in lower voluntary quit rates. In particular, worker control over the pace of work, a high degree of information sharing on issues related to establishment performance, and formal, off-the-job training for work-related skills were found to significantly reduce the establishment quit rate. Quit rates were also lower in firms with wider use of computers in the production process. Managers can expect a higher quit rate if their organization has a cost-containment orientation, if workers have control over methods of work and if training imparts general skills.

Clearly some of our findings are consistent with the hypotheses associated with the High Performance Work System literature, especially those related to worker self-management, information sharing and training. But our finding that problem-solving committees, even those that meet frequently, are not associated with lower quit rates and that training for worker participation in problem-solving committees is positively related to quit rates runs against the grain of the high performance work system concept.

Table 1. Summary Statistics

	Mean	Std. Dev.	Min	Max
Dependent Variable				
Voluntary quits in past year (% of total employment)	7.05	12.71	0	100
Independent Variables				
Estabishment-Level Control Variables				
Establishment age (years)	36.0	27.7	2	162
Managers & professionals (% of total employment)	26.2	13.9	0	60
Blue collar workers (% of total employment)	63.2	17.3	2	99
Average education of employees (years)	13.0	1.12	9.9	16.6
Manufacturing scale (ln(sq.ft.))	10.0	1.02	6.9	12.6
Number of different products produced in past year	832.2	3009.3	1	30000
Defense Prime or Subcontractor (dummy)	0.600	0.492	0	1
Industry Control Variables				
SIC 25 or 37 (dummy)	0.032	0.177	0	1
SIC 30 (dummy)	0.128	0.335	0	1
SIC 33 (dummy)	0.080	0.272	0	1
SIC 34 (dummy)	0.232	0.424	0	1
SIC 35 (dummy)	0.280	0.451	0	1
SIC 36 (dummy)	0.128	0.335	0	1
Regional Labor Market Control Variables				
Average Weekly Wage in Industry in County, 2003 (ln($))	6.72	0.25	6.17	8.17
Unemployment Rate in County, 2003 (%)	5.20	1.08	3.80	7.60
Operational Goal Orientation Variables				
Quality-oriented operational goals (factor)	0	0.881	-4.017	1.089
Cost-oriented operational goals (factor)	0	0.790	-2.721	1.367
Product-differentiation-oriented goals (factor)	0	0.731	-2.073	1.978
Worker Decision Making Variables				
Workers decide work methods (index)	0	1	-1.614	2.920
Workers set pace of work (index)	0	1	-1.110	2.827
Collaborative Communication & Technology Implementation Variables				
Breadth of computer use in establishment (index)	0	1	-2.532	1.491
Worker-management meetings on new technologies (index)	0	1.964	-1.748	5.439
Worker-management meetings on other production issues (index)	0	1	-1.132	1.058
Degree of corporate information sharing with workers (factor)	0	0.759	-1.435	1.948
Training Variables				
Worker training budget (% of total budget)	3.35	4.17	0	30
Workers receiving professional skills training (% of total employment)	15.1	23.4	0	100
Training reliant on informal in-house mentoring (factor)	0	0.881	-1.099	3.262
Training reliant on external sources (factor)	0	0.824	-1.952	2.840
Worker Incentive Policy Variables				
Profit sharing or stock ownership plan available for workers (dummy)	0.552	0.499	0	1
Performance-based bonuses for workers (dummy)	0.704	0.458	0	1

Table 2. Factor Analysis of Manufacturing Operational Goals

Manufacturing Operational Goal	Kaiser Varimax-rotation Factor Loadings Factor 1	Factor 2	Factor 3	Uniqueness
Operation within budget for new product development projects	0.171	0.060	**0.466**	0.725
Reduction of product lead time	**0.447**	0.013	0.300	0.659
Reduction in product defects	**0.791**	0.085	-0.027	0.359
Increase in productivity	0.355	**0.524**	-0.085	0.572
Reduction in product cost	0.085	**0.522**	0.135	0.571
Reduction in rework cost	**0.485**	0.334	0.049	0.555
Reduction in direct labor	0.059	**0.644**	0.081	0.562
Improving the integration between the design & manufacturing fuctions	0.271	-0.092	**0.472**	0.665
Increasing product variety	0.004	0.202	**0.538**	0.659
Improving product quality	**0.751**	0.070	0.195	0.337
Increasing process flexibility	**0.459**	0.314	0.268	0.573
Obtaining competitive advantage	**0.436**	0.183	0.063	0.662
Better management control	0.293	0.277	0.149	0.679
Eigenvalue (before rotation)	3.102	0.873	0.714	
Proportion	.718	.202	.165	

Table 3. Factor Analysis of Information Sharing with Employees

Information Type	Kaiser Varimax-rotation Factor Loadings Factor 1	Factor 2	Uniqueness
General Financial Status of Company	.618	-.009	.618
Financial information about products costs and profit levels	.434	-.058	.808
Production related information such as production goals, quality levels, etc	.387	.012	.835
Location's strategic plans	.597	.097	.634
Eigenvalue (before rotation)	1.082	.023	
Proportion	1.402	.030	

Table 4. Factor Analysis of Training Sources for Design & Manufacturing

Training Type-Source Pairing	Kaiser Varimax-rotation Factor Loadings		
	Factor 1	Factor 2	Uniqueness
Fundamental Skills Training Main Training Provider:			
State, Federal or Local Government-funded agencies	dropped, no positive responses		
Vendors or Distributors of Technology	-.066	**.409**	.567
Business-Industry Association	-.014	**.308**	.555
Local Academic Institution	-.124	-.018	.897
Formal in-house training by peers	**-.314**	-.172	.732
Informal in-house mentoring sessions	**.585**	.045	.474
Other	-.068	-.113	.851
Professional Skills Training Main Training Provider			
State, Federal or Local Government-funded agencies	-.018	**.453**	407.
Vendors or Distributors of Technology	dropped, no positive responses		
Business-Industry Association	-.189	**.397**	.571
Local Academic Institution	-.186	-.078	.620
Formal in-house training by peers	**-.216**	**-.413**	.567
Informal in-house mentoring sessions	**.341**	-.038	.759
Other	.027	-.168	.596
Manufacturing Foundation Skills Main Training Provider			
State, Federal or Local Government-funded agencies	.038	**.471**	.336
Vendors or Distributors of Technology	-.035	.028	.642
Business-Industry Association	.065	**.409**	.466
Local Academic Institution	-.141	.075	.583
Formal in-house training by peers	**-.580**	**-.288**	.385
Informal in-house mentoring sessions	**.705**	-.132	.405
Other	.018	**-.298**	.541
CAD/CAM-Related Skills Main Training Provider			
State, Federal or Local Government-funded agencies	dropped, no positive responses		
Vendors or Distributors of Technology	-.053	**.308**	.493
Business-Industry Association	-.014	.157	.698
Local Academic Institution	-.039	.094	.647
Formal in-house training by peers	**-.367**	-.169	.546
Informal in-house mentoring sessions	**.499**	-.116	.549
Other	.048	**-.245**	.633
Eigenvalue (before rotation)	2.01	1.64	
Proportion	0.237	0.193	

Table 5. Regression Results

Independent Variable: Voluntary quits in past year (% of total employment)

Dependent Variables	Tobit			OLS			Tobit			OLS		
Estabishment-Level Control Variables	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|	Coef.	Std. Err.	P>|t|
Establishment age (years)	0.023	0.058	0.687	0.043	0.045	0.341	-0.005	0.048	0.923	0.018	0.040	0.653
Managers & professionals (% of total employment)	0.001	0.196	0.998	-0.086	0.146	0.558	-0.003	0.179	0.986	-0.072	0.144	0.618
Blue collar workers (% of total employment)	0.161	0.165	0.331	0.056	0.125	0.657	0.112	0.145	0.442	0.016	0.118	0.893
Average education of employees (years)	-1.994	1.645	0.228	-1.654	1.306	0.208	-0.927	1.523	0.544	-1.446	1.286	0.264
Manufacturing scale (ln(sq.ft.))	1.141	1.572	0.469	-0.414	1.236	0.738	3.278	1.442	0.025	1.440	1.194	0.231
Number of different products produced in past year	-0.0002232	0.0004585	0.627	-0.000173	0.0003727	0.643	-0.000486	0.0003973	0.224	-0.0003596	0.0003466	0.302
Defense Prime or Subcontractor (dummy)	-7.246	3.100	0.021	-5.874	2.446	0.018	-3.242	2.791	0.248	-2.127	2.388	0.375
Industry Control Variables												
SIC 25 or 37 (dummy)	-11.621	9.112	0.205	-8.853	7.005	0.209	-9.613	7.791	0.22	-7.889	6.489	0.227
SIC 30 (dummy)	-2.708	5.824	0.643	-4.035	4.607	0.383	-1.973	5.121	0.701	-4.047	4.364	0.356
SIC 33 (dummy)	7.349	6.707	0.276	6.034	5.307	0.258	5.168	6.332	0.416	4.916	5.319	0.358
SIC 34 (dummy)	-9.159	5.529	0.1	-7.284	4.231	0.088	-10.659	4.897	0.032	-8.239	4.036	0.044
SIC 35 (dummy)	-5.934	5.119	0.249	-4.995	3.933	0.207	-7.294	4.393	0.1	-5.856	3.612	0.108
SIC 36 (dummy)	1.702	6.007	0.777	0.523	4.693	0.911	2.956	5.333	0.581	1.490	4.370	0.734
Regional Labor Market Control Variables												
Average Weekly Wage in Industry in County, 2003 (ln($))	-1.583	7.245	0.827	-1.632	5.473	0.766	2.355	6.389	0.713	0.520	5.304	0.922
Unemployment Rate in County, 2003 (%)	0.050	1.540	0.974	0.343	1.214	0.778	-0.064	1.348	0.962	0.199	1.134	0.861
Operational Goal Orientation Variables												
Quality-oriented operational goals (factor)							0.522	1.629	0.749	-0.782	1.271	0.54
Cost-oriented operational goals (factor)							2.981	1.728	0.088	1.909	1.420	0.182
Product-differentiation-oriented goals (factor)							0.850	1.879	0.652	1.319	1.580	0.406
Worker Decision Making Variables												
Workers decide work methods (index)							2.564	1.450	0.08	2.581	1.199	0.034
Workers set pace of work (index)							-3.498	1.314	0.009	-3.456	1.101	0.002
Collaborative Communication & Technology Implementation Variables												
Breadth of computer use in establishment (index)							-4.337	1.500	0.005	-3.438	1.216	0.006
Worker-management meetings on new technologies (index)							-0.225	0.991	0.821	0.312	0.841	0.712
Worker-management meetings on other production issues (index)							0.523	2.071	0.801	-0.339	1.746	0.846
Degree of corporate information sharing with workers (factor)							-4.035	2.152	0.064	-3.224	1.831	0.082
Training Variables												
Worker training budget (% of total budget)							-0.006	0.004	0.088	-0.005	0.003	0.109
Workers receiving professional skills training (% of total employment)							4.981	2.950	0.095	3.745	2.500	0.137
Training reliant on informal in-house mentoring (factor)							3.107	1.617	0.058	2.791	1.328	0.038
Training reliant on external sources (factor)							0.678	1.513	0.655	-0.221	1.264	0.862
Worker Incentive Policy Variables												
Profit sharing or stock ownership plan available for workers (dummy)							-1.170	2.616	0.656	-1.697	2.199	0.442
Performance-based bonuses for workers (dummy)							1.476	2.644	0.578	2.813	2.267	0.218
Constant	25.461	55.918	0.65	46.038	42.417	0.28	-32.496	49.639	0.514	11.593	39.985	0.773
	LR chi2(15)	26.2		F(15, 109)	1.96		LR chi2(30)	56.28		F(30, 93)	2.46	
	Prob > chi2	0.036		Prob > F	0.0246		Prob > chi2	0.0025		Prob > F	0.0005	
	Log likelihood	-380.04121		R-squared	0.2125		Log likelihood	-357.09094		R-squared	0.4423	
	Pseudo R2	0.0333		Adj R-squared	0.1041		Pseudo R2	0.0731		Adj R-squared	0.2624	
				Root MSE	12.033					Root MSE	10.441	

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