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FIRM SIZE AND OCCUPATIONAL INJURY AND ILLNESS INCIDENCE RATES IN MANUFACTURING INDUSTRIES

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ABSTRACT: Information was gathered from a Department of Labor (DOL) publication on firm size and occupational injuries and illnesses. Twenty-eight large industries were selected which contained information on injury and illness rates for all eight categories of firm sizes. The injury and illness information was matched to data on percent of production workers, percent women, weekly earnings and weekly hours in the 28 industries. After controlling for gender, earnings, hours and percent production workers, as well as idiosyncratic effects of the particular industries, the evidence suggests that very small firms (1-19 employees) and very large firms (1,000 employees or more) have the fewest injuries and illnesses, and medium sized firms, 20 to 999 employees, have the most.

INTRODUCTION

Many aspects of the 1970 Occupational Safety and Health Act (OSHA), mostly relating to the promulgation and enforcement of standards, have generated lively controversy among business people, labor leaders, policy makers and academics. However, in the area of information gathering, OSHA has generated far less controversy. Most observers appreciate that more information on occupational injuries and illnesses is gathered now than prior to 1970. Yet, researchers have been slow to make use of the data. While research using case studies in particular occupations or industries has continued to expand, research making use of national probability samples and Department of Labor, OSHA publications containing information on national averages has been lagging. This is unfortunate since it is difficult to determine whether findings in case studies in particular locations are relevant for national OSHA policy.

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This study represents an attempt to begin to fill the void. The data on occupational injuries and illnesses were drawn from a Department of Labor publication on manufacturing industries. The independent variable of interest was firm size, while the dependent variable was the injury and illness incidence rates. The number of employees in a firm has been found to be a correlate of accidents in coal mines.[1] But, aside from coal mining, little attention has been given to firm size as a possible correlate of industrial injuries and illnesses. A literature search for the previous 10 years uncovered only one article which had both firm size and occupational injuries as key words. By contrast, in economics, the effect of firm size on wages, for example, has received enormous attention.[2,3]

The one study identified in the literature search was conducted by Parkinson et al.[1] on workplace deaths in Allegheny County. They looked at death certificates and discovered 41 job-related deaths in 1983 and 1984. Surprising, approximately 40% of the accidents were not within the OSHA jurisdiction and consequently would not have entered OSHA or Department of Labor statistics. Parkinson et al. found that nearly 80% of the fatal accidents occurred at locations with fewer than 100 employees. Because of small sample sizes, however, Parkinson et al. could not consider whether there was any difference between the smallest firms, say, with 1 to 19 employees versus other firms with 20 to 49, or 50 to 99 employees.

There are several advantages and one disadvantage of the OSHA data that are relied on in this study. The first advantage is that the OSHA data are drawn from throughout the nation, not just from one county. The second advantage is that all injuries and illnesses, not just fatalities, are included. The third advantage is that because cell sizes are large enough, information on a variety of firm sizes, e.g., 1 to 19, 20 to 49, 50 to 99 and so on, can be analyzed. The disadvantage is that the OSHA statistics might be missing approximately 40 percent of all occupational injuries and illnesses.

There are reasons to believe that firm size ought to be related to injuries and illnesses. Larger, wealthier firms may be able to spend more to protect workers from hazards. Small firms, on the other hand, may be more selective in hiring healthy, safety-conscious workers since many small firms rely so heavily on employment of friends and relatives.

Evidence from empirical studies in economics also suggests the importance of a relationship. Both large firm size[2,3] and hazardous conditions at the job[3] have been found to be associated with higher

wages, other things equal. If hazardous conditions and firm size are related, then economic estimates of the effects of, say, hazardous conditions on wages which do not control for firm size will be biased.

Since no strong *a prior* notion indicates what form the firm size and injury and illness rates relationship should take, if any, this study is exploratory and will not impose any particular functional form.

DATA

Every year the Department of Labor publishes *Evaluating Your Firm's Injury and Illness Record*[6] which contains information on injury and illness rates for most three digit (s.i.c. codes) manufacturing industries. The data are collected in accordance with provisions of the Occupational Safety and Health Act of 1970. The data to be used in the analysis below were drawn from the *1982 Record*, published in April, 1984.

The calculation of an industry's injury and illness incidence rate can be illustrated with an example. Consider firms with 1 to 19 employees in the household furniture industry in 1982. The Department of Labor collects information on the number of injuries and illnesses with and without lost work days, and the number of hours all employees actually worked during the year. The Department of Labor uses 100 employees working 40 hours per week for 50 weeks, or 200,000 annual hours, as a basis for comparison. An incidence rate is then calculated for firms with 1 to 19 employees in the household furniture industry as follows:

$$\frac{\text{number of injuries and illnesses}}{\text{employees hours worked}} \times 200{,}000 = \text{incidence rate per 100 full-time workers}$$

Again, 200,000 is used to standardize the rates for 100 full-time workers.

Table 1 presents the 1982 average incidence rates per 100 full-time workers by firm size in household furniture. The smallest rate in household furniture appears to be for firms with 1 to 19 employees and firms with over 2,500 employees, while the largest rates appear to be for firms with 100 to 249 employees.

While the *1982 Record* contains information on some 100 manufacturing industries, the analysis considers only twenty-eight. The 28 considered are electric lighting and wiring equipment; electrical industrial operations; electronic components and accessories; household ap-

TABLE 1

Average Occupational Injury and Illness Incidence Rates per 100 Full-Time Workers in Household Furniture in 1982

Firm Size	*Average Incidence Rates*
all sizes	12.7
1 to 19	5.1
20 to 49	11.6
50 to 99	15.9
100 to 249	16.2
250 to 499	13.4
500 to 999	9.5
1,000 to 2,499	11.1
2,500 and over	7.0

Data from the U.S. Department of Labor, Bureau of Labor Statistics, *Evaluating Your Firm's Injury and Illness Record, 1982*, Manufacturing Industries, Report 706, April 1984, Washington, D.C.

pliances; miscellaneous electrical equipment and supplies; fabricated structural metal products; metal forgings and stampings; household furniture; measuring and controlling devices; construction and related machinery; farm and garden machines; refrigeration and service machinery; blast furnace and basic steel products; basic and steel factories; aircraft and parts; guided missiles, space vehicles and parts; motor vehicles and equipment; ship and boat building and repairing; industrial inorganic chemicals; industrial organic chemicals; soap cleaners and toilet goods; beverages; grain mill products; miscellaneous foods; tires and inner tubes; and knitting mills.

The 28 selected were the only industries out of the roughly 100 manufacturing industries in the *1982 Record* with incidence rates for all eight categories of firm size: 1 to 19; 20 to 49; 50 to 99; 100 to 249; 250 to 499; 500 to 999; 1,000 to 1,499; over 2,500. The roughly 70 excluded industries either had no incidence rates for firms that were very small or very large. In the multiple regression analysis that follows, data were required on each of the categories of firm size for each industry so that a comprehensive view could be produced on the association between firm size and industry and illness rates.

Because firm size is unlikely to be the only covariate of injury and illness rates, information was collected on control variables which

were suspected to be associated with injury and illness rates in industry. Percent of women, percent of production workers, as well as weekly earnings and hours for employees have been alleged to influence industry statistics on injuries and illness. Information on the four control variables was gathered for each of the 28 industries identified above from the Department of Labor's *Employment and Earnings* bulletins.[7]

METHOD

The analysis relied on two methods. The first involves a simple assessment of all the individual rates and the mean rates for all 28 industries within each of the 8 firm size categories. A diagram is presented which displays all the rates and the means for the rates against the 8 firm size categories.

The second method assesses the association between firm size and injury and illness rates using multiple regression techniques which are equivalent to analysis of variance when independent variables are binary.

RESULTS

Figure 1 displays a plot of all 224 (28 industries × 8 categories) observations and the 8 means on the 28 industries and 8 firm size categories. The incidence rate is measured along the vertical axis and the firm size categories along the horizontal axis. The means are the large dots and are connected by a solid line.

The data appear to display a non-normal distribution with a peak at 50 to 99 employees and a long right tail. The line connecting the means rises quickly, is almost flat between the 20 to 49 and 100 to 249 categories, and slowly falls for the larger firm size categories.

Three multiple regressions were run to determine whether the pattern observed in Figure 1 was due only to chance. The results from the multiple regressions suggest that the pattern is statistically significant.

Table 2 column 1 presents the results from regressing the incidence rates on only binary variables for the firm size categories. The multiple regression F-test, which appears at the bottom of the table, is equivalent to the test statistic for an analysis of variance when all explanatory variables are binary.[8]

Since the F-test for the regression is significant at better than the .0001 level, one can conclude that the pattern in the data suggest a

Figure 1. Plot of injury and illness rate against firm size.

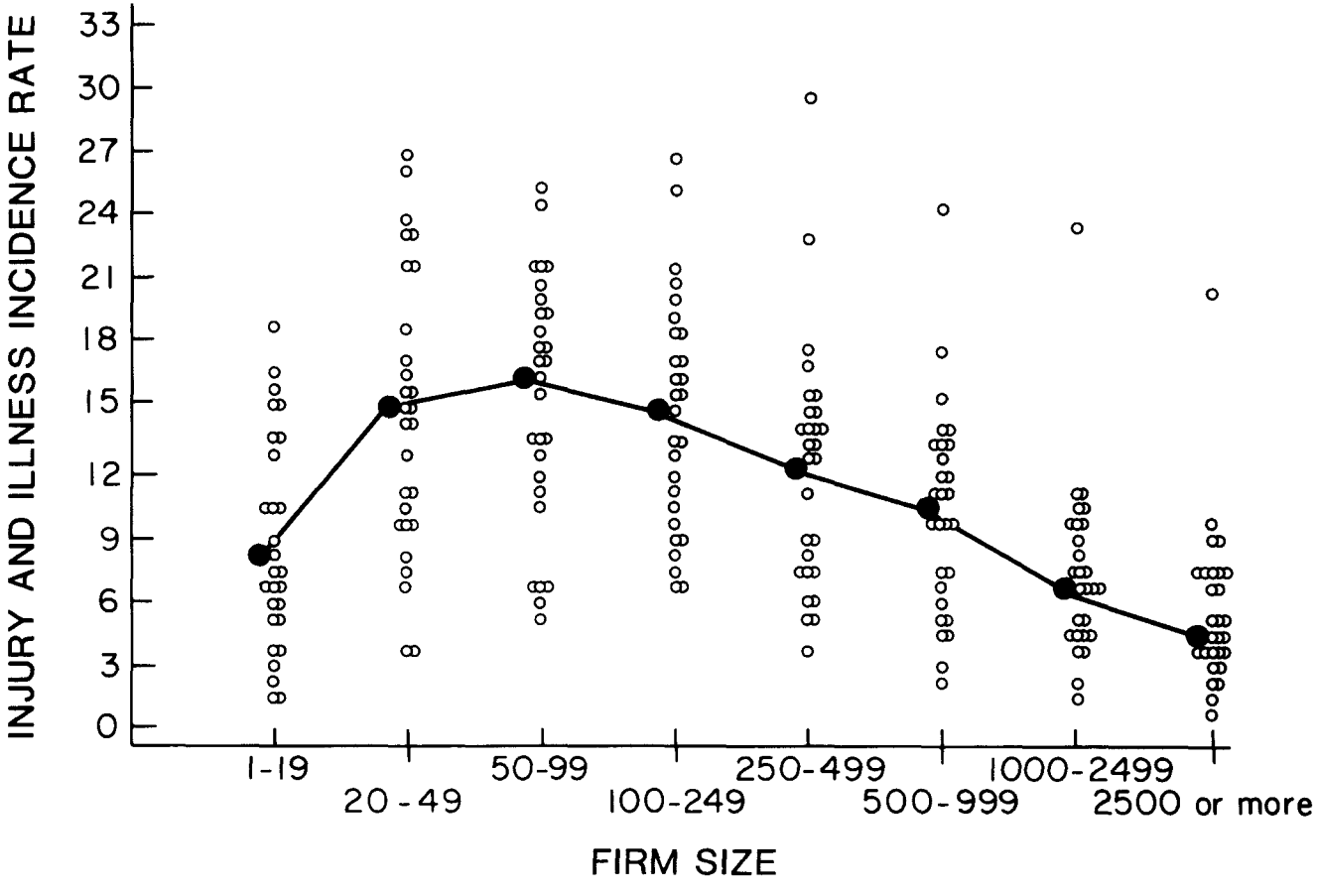

TABLE 2

Multiple Regression Results Explaining Occupational Injury and Illness Rates

Independent or Explanatory Variables	*Unstandardized Regression Coefficient and (t-Statistic)*		
	1	*2*	*3*
Firm size categories			
1-19 = 1; otherwise = 0	2.840*	2.839*	2.478*
	(2.749)	(2.008)	(1.983)
20-49 = 1; otherwise = 0	9.032*	9.032*	8.516*
	(8.744)	(6.388)	(5.451)
50-99 = 1; otherwise 0	9.771*	9.741*	9.063*
	(9.460)	(9.911)	(6.340)
100-249 = 1; otherwise = 0	9.042*	9.043*	8.156*
	(8.755)	(6.396)	(5.992)
250-499 = 1; otherwise = 0	6.603*	6.543*	6.984*
	(6.393)	(4.671)	(4.323)
500-999 = 1; otherwise = 0	4.657*	4.610*	4.843*
	(4.464)	(3.294)	(3.116)
1,000-2,499 = 1; otherwise = 0	1.809	1.897	1.920
	(1.820)	(1.268)	(1.147)
(omitted category 2,500 or more) = (intercept in col. 1 only)	5.760*		
	(5.762)		
intercept for cols. 2 and 3		10.925	11.617
		(.960)	(.870)
Demographics and Wages			
percent production workers		11.719*	10.859*
		(4.292)	(3.362)
percent women		−31.839*	−20.774*
		(10.213)	(6.434)
weekly hours		.137	.052
		(.490)	(.331)
weekly earnings		−.027*	−.020*
		(3.998)	(2.771)
27 binary variables for 28 industries	excluded	excluded	excluded
R^2	.3080	.6380	.7763
F	13.673	33.807	59.567
probability of type 1 error for F	<.0001	<.0001	<.0001

*indicates significance at the .05 level in a two-tailed test

"true" pattern exists in the population or universe between firm size and injury and illness rates for these manufacturing industries. But, multiple regression is more informative than AOV since it can suggest what the pattern is.

Means at incidence rates within each of the 8 firm size categories can be calculated from the regression coefficients (if *only* column 1) as indicated in Kennedy.[8] The mean incidence rate for the largest category, over 2,500 employees, is simply the estimated intercept—5.760. The mean for any of the other categories is simply 5.760 plus the regression coefficient for that category. Thus, the mean for the 1 to 19 category is 5.760 + 2.840 = 8.600, and so on.

The evidence in column 1 suggests that the pattern in Figure 1 is statistically significant. All but one of the coefficients (on 1,000 to 2,499) are statistically significant at better than the .05 level in a two-tailed test (the coefficient on 1,000 to 1,449 is significant at the .10 level in a two-tailed test). However, statistical significance for binary variables indicate that the hypothesis that the "true" coefficient on the category on interest, say, 1 to 19, is different from the intercept or the coefficient for the omitted category. Moreover, the means rise from 8.600 for the 1 to 19 category to 15.531 (5.76 + 9.771) for the 50 to 99 category, and fall thereafter.

To determine whether or not the results in column 1 were robust, additional explanatory variables were added to the model. Percent production workers, percent women, weekly hours and earnings have been implicated as covariates of occupational injuries and illness (see Leigh[9] and Robertson & Keeve[10]). The data on production workers, gender, hours and earnings apply to the 28 industries and are not specific to the 8 firm size categories. Percent female employment and weekly earnings are associated with lower incidence rates while percent of production workers is associated with higher incidence rates. Weekly hours did not display any statistical association in these data.

As an additional test, 27 binary variables representing the 28 industries (1 binary variable must be omitted to break the multicollinearity) were added as new explanatory variables in column 3, and the results on the 27 binary variables are available from the author. Binary variables representing each of the industries remove any idiosyncratic association of each industry on the injury and illness rate. Despite the new variables considered in columns 2 and 3, the statistically significant pattern emerges between firm size and incidence rates. The estimated coefficients for the smallest and largest firm size categories continue to be smaller than those for the small to medium sizes.

DISCUSSION

The results suggest that, other things equal, small firms, with 1 to 19 employees and large firms with 1,000 or more employees tend to have the best injury and illness records. Larger firms may either spend considerably more than medium sized firms on interviewing and screening prospective employees, as suggested by Garen,[3] and as a result hire healthier and safer employees; or spend more on safe workplaces, or both. The findings for small firms were not expected, but a few explanations can be offered. It may be that small firms are more likely to under-report (and get away with it) since OSHA standards are not as stringent for small firms. Alternatively, small firms are generally owner-operated. The owner may want to maintain a high level of safety since he or she may be exposed to danger. Finally, small firms may hand-pick their employees from among friends and relatives who are selected, in part, perhaps because of their overall good health and safety awareness.

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