DIRECT AND INDIRECT EFFECTS OF REGULATION: A NEW LOOK AT OSHA'S IMPACT*

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I. Introduction

An extended series of economic studies has failed to find any statistically significant impact on national injury rates due to the Occupational Safety and Health Administration, or OSHA.[1] Two distinct explanations for this apparent failure of OSHA have been put forward in these studies. The first is that, because of limited statutory and budgetary authority from Congress, OSHA is unable to compel industrial compliance with its own standards. Advocates of this position point to the pitifully small level of OSHA fines and to the small number of firms that will actually be inspected. For example, in 1975, the average fine per violation amounted to only $26, while the average number of inspections per firm was only .02,

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[1] Aldona DiPietro, An Analysis of the OSHA Inspection Program in Manufacturing Industries 1972–73 (Draft Tech. Analysis Paper, Office of the Assistant Secretary for Policy, Planning, and Evaluation, U.S. Dep't Labor 1976); John Mendeloff, An Evaluation of the OSHA Program's Effect on Workplace Injury Rates: Evidence from California through 1974 (Report prepared for the Office of the Assistant Secretary for Policy, Evaluation, and Research, U.S. Dep't Labor 1976); *id.*, Regulating Safety: An Economic and Political Analysis of Occupational Safety and Health Policy (1979); Robert S. Smith, The Occupational Safety and Health Act: Its Goals and Achievements (1976); and W. Kip Viscusi, The Impact of Occupational Safety and Health Regulation, 10 Bell J. Econ. 117 (1979). Recent studies with more optimistic findings include William N. Cooke & Fredrick H. Gautschi III, OSHA, Plant Safety Programs and Injury Reduction, 20 Indus. Rel. 245 (1981); and Robert S. Smith, The Impact of OSHA Inspections on Manufacturing Injury Rates, 14 J. Human Resources 145 (1979).

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implying an expected fine per violation of 52 cents.[2] From this perspective then, noncompliance is the root of OSHA's failure. A second argument is that the Occupational Safety and Health Act is itself flawed, because it emphasizes standards for capital equipment when most accidents are in fact caused by complex epidemiological interactions of labor, equipment, and the workplace environment. Since OSHA standards address only part of the problem, these standards can have at best minimal effect.[3] For purposes of this study, the first of these explanations will be called the "noncompliance hypothesis" and the second will be labeled the "inefficacy hypothesis."

Although there is in fact widespread verbal support for the noncompliance hypothesis in the literature, this hypothesis leads immediately to two significant dilemmas:

1. Alongside studies suggesting that OSHA's failure to achieve compliance is due to inadequate enforcement are other studies indicating that OSHA imposes enormous financial burdens on industry. One such report estimates OSHA compliance costs of almost $2.7 billion a year.[4] Clearly, OSHA enforcement cannot be completely ineffective if these cost-focused studies are at all valid.
2. OSHA safety regulations and their enforcement were continuously supported and funded by Congress throughout the decade 1970–80 despite significant Congressional controversy.[5] If OSHA enforcement is completely inconsequential, this political support cannot be rational.

We argue here that effective resolution of these dilemmas can be achieved only by expanding the range of issues considered in an analysis of OSHA. Past studies of OSHA have been restricted almost exclusively to examinations of the determinants of injury rates, estimating with single-equation techniques the effects of OSHA enforcement on worker accidents. This approach is extremely limited for two reasons.

First, the traditional approach excludes specific consideration of corporate noncompliance with OSHA standards. The relationships (if any) between accidents and violations (the inefficacy hypothesis) and between violations and enforcement (the noncompliance hypothesis) thus cannot

[2] Richard Zeckhauser & Albert Nichols, The Occupational Safety and Health Administration: An Overview, in 6 The Study on Federal Regulation of the Senate Committee on Governmental Affairs 163, 205–8 (1978).

[3] Mendeloff, Regulating Safety, *supra* note 1, at 85–87; and Zeckhauser & Nichols, *supra* note 2, at 189–91.

[4] Murray Weidenbaum & Robert DeFina, The Cost of Federal Regulation of Economic Activity (AEI Reprint No. 88, 1978).

[5] Steven Kelman, OSHA, in The Politics of Regulation 236, 256–63 (James Q. Wilson ed. 1980).

be isolated and examined.[6] Yet the inefficacy and noncompliance hypotheses have profoundly different implications for public policy, so that formulation of an appropriate policy response requires not merely a demonstration that OSHA fails but an understanding of why that failure occurs.

More important, however, traditional analyses of OSHA have focused on what we will call the "direct effects" of regulation—the isolated partial equilibrium impacts on single firms or individuals. Among the direct effects of OSHA are improvements in safety for workers and increases in manufacturing costs that decrease profits and wages. Alongside these direct effects however, are the general equilibrium "indirect effects"—the competitive advantages that arise from the asymmetrical impacts of regulation among different groups of firms and workers. For example, if the cost burden of certain regulations falls heavily on one group of firms and lightly on a second group, then an indirect effect of these regulations is to provide competitive advantage to the second group of firms. It is extremely important to recognize that, for many firms and workers, the indirect effects of regulation can outweigh the direct effects in economic importance. If the competitive advantage gained through indirect effects is sufficiently large, it can more than offset any direct costs, producing a net benefit for the regulated firm and its workers. The Consumer Product Safety Commission's (CPSC) standard for swimming pool slides, the new source standards in the Clean Air Act, and the OSHA cotton dust standard are among the many regulations where indirect effects predominate.[7]

Expansion of the analysis to consider noncompliance and indirect effects suggests a resolution for the two dilemmas raised above. As regards the first dilemma, if the inefficacy hypothesis is true and the noncompliance hypothesis is false, then OSHA will fail to produce safety benefits, while simultaneously inducing substantial compliance costs. Second, even if OSHA has absolutely no safety benefits, it can indeed have a cost impact *and* be politically supported if this cost impact is sufficiently asymmetrically distributed (that is, sufficient indirect effects exist).

[6] When past studies have considered industrial violations of OSHA standards at all, they have treated OSHA penalty records, wrongly, as enforcement data rather than noncompliance data. The apparent inspiration for this mistreatment arises from cross-state economics-of-crime studies that examine the impact of different state penalty regimes on state crime rates. In the case of OSHA, however, heterogeneous industries confront a uniform penalty regime, with each industry choosing its extent of noncompliance and hence its volume of penalties.

[7] On the CPSC, see W. Kip Viscusi, Regulating Product Safety (1984). On the EPA, see Robert Crandall, Clean Air and Regional Protectionism, 2 Brookings Rev. 17 (1983). On OSHA, see Michael Maloney & Robert McCormick, A Positive Theory of Environmental Quality Regulation, 25 J. Law & Econ. 99 (1982).

In practice, data limitations prevent actual examination of compliance costs. The existence and magnitude of indirect effects, however, may be inferred from asymmetries of compliance and enforcement, as explained below. Addressing these issues, this study develops and tests a three-equation model of workplace injuries, corporate noncompliance with OSHA standards, and OSHA enforcement.[8]

In the following part of the paper the model is developed. Section III describes the data; results are presented in Section IV and conclusions and policy implications are given in Section V.

II. Model

A. *Introduction*

The Occupational Safety and Health Act directs the secretary of labor to promulgate and enforce safety and health standards. It is important to recognize that OSHA standards are not performance requirements that specify some maximum accident rate for each firm, but rather are design requirements for the workplace itself. Most OSHA standards are in fact capital equipment standards dictating, often in great detail, physical characteristics of plant and equipment. The agency conducts unannounced inspections to determine whether firms are in compliance. If the inspection discloses the violation of a standard, the employer is fined and ordered to comply within a specified abatement period.

Many industries would be largely in compliance with OSHA standards even in the absence of OSHA enforcement activity, simply because their technology involves little capital or few practices that can be regulated. We call these industries "naturally complying." Alternatively, some industries will be "naturally noncomplying" because their technology results in a low rate of compliance. The concept of natural noncompliance is distinct from the concept of "natural hazardousness," which measures the degree of unregulated worker safety. For example, police work is naturally hazardous but is also naturally compliant with OSHA's standards given the technology of the industry.

[8] The three-equation approach of the study addresses an additional problem with previous studies of OSHA, namely, simultaneity of accidents and enforcement. By its own accounts, OSHA does not randomly inspect industries, but explicitly targets for enforcement the firms with high accident rates—a so-called worst-first strategy. This targeting of enforcement has also occurred in special OSHA procedures such as the Target Industry Program, or TIP. Given this pervasive targeting, any negative enforcement effects on accidents could well be swamped by positive accident effects on enforcement, and the actual extent of OSHA enforcement would be masked by OLS estimation of a single-accident equation.

The nature of the OSHA program is therefore such that the efficacy of OSHA enforcement efforts depends critically on the extent of natural noncompliance. Even the most vigorous inspection of naturally complying industries will do little to reduce worker injuries simply because firms need make no changes in work processes. Any analysis of the effect of OSHA enforcement on worker injuries must thus control for the degree of natural noncompliance. In this section we develop an approach for analyzing the interrelationships among safety, compliance, and OSHA's enforcement efforts.

B. *The Accident Production Function*

Noncompliance with OSHA standards is an argument of the production function for workplace accidents (when OSHA standards are efficacious). The accident rate per employee (*AE*) can be written as

$$AE = f(VE, \mathbf{H}, EF) \quad f_{\mathbf{H}} > 0 \quad f_{VE} > 0 \quad f_{VE,VE} > 0, \tag{1}$$

where *VE* indicates violations (per employee) of OSHA standards, **H** represents a vector of technological and demographic variables that determine natural hazardousness, and *EF* is the number of employees in the firm. Derivative restrictions are as shown.

C. *Industrial Compliance with OSHA Standards*

Firms will elect to violate OSHA standards whenever such noncompliance is profit maximizing. Even apart from OSHA enforcement efforts, the level of noncompliance by a firm will have several distinct effects on profits. On the one hand, a movement toward compliance requires costly capital investments and changes in work patterns which add to production costs. On the other hand, greater compliance results in fewer injuries and hence the firm enjoys increased profits from fewer lost or restricted work days and smaller wage premia to compensate for job-related risks. In the absence of OSHA enforcement, each firm will choose the level of compliance that maximizes its profits. OSHA enforcement activities are geared toward penalizing firms that have not achieved the prescribed safety standards; thus each firm finds its optimal compliance level by maximizing the following expected profit (per worker) function:

$$\pi = NET(VE, \mathbf{K}, EF, UE) - \rho(IE)VE, \tag{2}$$

where $NET(\cdot)$ represents net revenues, or revenues minus all costs except those due to fines for violations of OSHA standards, **K** is a vector of technological variables that determine natural noncompliance, *UE* is the percentage of the workers that are unionized, *IE* is inspections per

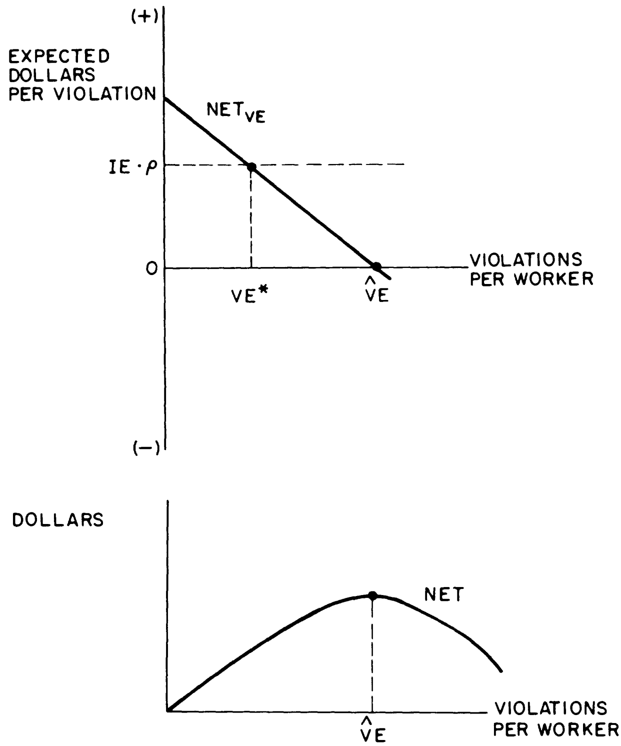

FIGURE 1

worker, and ρ is the penalty per violation. The profit-maximizing violation rate is given by

$$NET_{VE} - IE \cdot \rho = 0. \tag{3}$$

Figure 1 shows that in the absence of OSHA, the firm would choose $\hat{VE}$ violations. With OSHA in place, the firm's optimal violation rate is VE^* where $VE^* < \hat{VE}$.

Basic comparative statics for optimal violation rates can be seen by examination of equation (3) and Figure (1). An increase in the intensity of OSHA enforcement by an increase in either ρ or IE will induce the firm to violate fewer standards. Also, changes in technology will shift the NET_{VE} function thereby resulting in a different $\hat{VE}$ and VE^*. For example, as the degree of natural noncompliance (K) increases, NET_{VE} shifts up and the firm's natural violation level and its optimal violation level in the presence of OSHA both increase. Thus we have the following comparative static results:

$$VE^*_{IE} < 0 \quad VE^*_{\rho} < 0 \quad VE^*_{K} > 0. \tag{4}$$

Indirect effects of regulation arise from two possible sources: a "compliance asymmetry" whereby one firm suffers a greater cost burden per employee even when regulations are evenly enforced across firms, or an "enforcement asymmetry" whereby regulations are more vigorously enforced against certain firms. When compliance asymmetries exist, violation rates will be higher because of the higher marginal cost of compliance. There appear to be two principal sources of compliance asymmetries due to OSHA regulations. First, to the extent that there are economies of scale in compliance, smaller firms suffer a larger unit-cost impact and in fact may be so disadvantaged as to exit the industry. Pashigian has provided evidence of economies of scale in compliance with environmental regulations, and Neumann and Nelson have documented the exit of small mines resulting from enforcement of the 1969 Coal Mine Health and Safety Act.[9] Economies of scale in compliance can thus be expected to enable regulatory transfer of wealth from small to large firms. Second, to the extent that unionized firms exhibit higher preregulation safety levels, OSHA enforcement can benefit unionized firms by forcing nonunion competitors to match union-dictated safety levels. OSHA regulation can thus reduce competitive pressure on unionized firms and workers, transferring wealth to these firms and workers from the nonunionized segment of the industry. We therefore expect the additional comparative static results that $VE^*_{EF} < 0$ and $VE^*_{UE} < 0$.

D. OSHA Enforcement

The economic theory of regulation developed by Stigler and Peltzman argues that the regulatory agency acts to maximize net political support, or the difference between support and opposition of constituents.[10] Individuals who receive net economic benefits from regulation are regarded as supporting the agency, and their support increases at a decreasing rate with net benefits. Individuals who suffer net economic losses from regulation are regarded as opposing the agency, and their opposition increases

[9] Peter Pashigian, The Effect of Environmental Regulation on Optimal Plant Size and Factor Shares, 27 J. Law & Econ. 1 (1984); George Neumann & Jon Nelson, Safety Regulation and Firm Size: Effects of the Coal Mine Health and Safety Act of 1969, 25 J. Law & Econ. 183 (1982).

[10] George Stigler, The Theory of Economic Regulation, 2 Bell J. Econ. 3 (1971); Sam Peltzman, Toward a More General Theory of Regulation, 19 J. Law & Econ. 211 (1976).

at an increasing rate with net losses. Marginal net political support thus falls with the scale of regulatory transfer (what we will call "satiation effects"). In addition, organized interests are assumed to provide stronger marginal political support or opposition (what we will call "organization effects").

Net political support for inspection of a firm may be defined as:

$$NPS = N[T(IE, \mathbf{K}), EF, UE, \pi, AE, WE], \tag{5}$$

where T represents the per capita transfer of wealth to (when $T > 0$) or from (when $T < 0$) the inspected firm. The scale of these transfers depends on the level of OSHA enforcement (IE) and $\mathbf{K}$, the extent of natural noncompliance, with derivative restrictions as follows:

$$T_{\mathbf{K}} > 0,\ T_{IE} > 0,\ T_{\mathbf{K},IE} > 0.$$

For any fixed inspection budget, constrained maximization of NPS implies:

$$N_T T_{IE} = \lambda \geqslant 0, \tag{6}$$

for some λ constant across all firms.

Greater natural noncompliance by the firm increases regulatory transfer, producing two offsetting comparative static effects. First, because marginal political support diminishes with the transfer while marginal political opposition increases, greater natural noncompliance lowers marginal net political support and thus decreases the politically optimal inspection rate when inspections are productive (the satiation effect). Second, because the same number of inspections now produces greater transfer and greater political response, greater natural noncompliance increases the optimal inspection rate (the productivity effect). Formally, differentiation of (6) using the implicit function theorem gives:

$$\frac{\partial IE}{\partial \mathbf{K}} = -\frac{N_{TT} T_{\mathbf{K}} T_{IE} + N_T T_{\mathbf{K},IE}}{N_T T_{IE}^2 + N_T T_{IE,IE}}. \tag{7}$$

The denominator of (7) is negative by the second-order condition for the maximization of (5). When inspections are productive ($T_{IE} > 0$), the first term of the numerator (the satiation effect) is negative by the economic theory of regulation, and the second term (the productivity effect) is positive. The comparative static effects on enforcement of greater natural noncompliance are thus of ambiguous sign.

Additional satiation effects may be examined in the context of the economic theory of regulation. As Peltzman first argued, nonregulatory variables that affect the marginal utility of income also produce satiation effects and thus alter optimal levels of regulatory transfer.[11] For example, higher profits due to nonregulatory factors should mitigate corporate opposition to the burden of regulation-induced costs. In order to apply Peltzman's argument in our analysis, we need to consider separately the political satiation effects that arise from direct and indirect transfers of wealth. Consider first the direct effects of OSHA safety enforcement. These direct effects consist of financial losses (increased costs) and safety gains within inspected firms. An exogenous increase in wealth (profits and wages) for inspected firms should lower the marginal utility of wealth, producing a satiation effect—lessened opposition to regulation-imposed costs, ceteris paribus, and thus greater marginal net political support for regulatory transfer via enforcement. Increased accident rates within the inspected firm also lower the marginal utility of wealth, and thus also increase marginal net political support for OSHA-administered regulatory transfers.

The implications of satiation effects for optimal enforcement levels are complicated by the presence of indirect effects of OSHA regulation. Greater financial wealth in the inspected industry should lower the marginal utility of wealth for both beneficiaries and losers of indirect transfers, lowering both marginal (gross) support and marginal opposition generated by indirect transfers. Higher accident rates produce similar offsetting results for indirect transfers. For purposes of this study, we will regard the political satiation effects produced by indirect transfers from OSHA safety regulation as self-canceling, leaving only the unambiguously signed satiation effects due to direct transfers. Thus we have the following comparative statics predictions (with *WE* as the average wage):

$$\frac{\partial IE}{\partial \pi} > 0 \quad \frac{\partial IE}{\partial WE} > 0 \quad \frac{\partial IE}{\partial AE} > 0.$$

An additional set of comparative statics results arises because of organizational effects. For example, workers in establishments that are unionized or that are large (high *EF*) are more easily organized for political activity. The agency would thus be more politically responsive to these establishments and would seek to create indirect transfers of wealth to them through enforcement asymmetries. In other words, OSHA would inspect nonunion and small firms more heavily in order to impose higher costs on these competitors to union and large firms. Thus, when there is a greater proportion of nonunion or small firms in an industry, there are greater opportunities for politically advantageous transfer, and inspection

[11] Peltzman, *supra* note 10, at 224–28.

rates will be higher in that industry. Greater variance around mean firm size and unionization rate also indicates greater opportunity for regulatory transfer; only the variance of firm size, however, is measurable in our study. Thus we have

$$\frac{\partial IE}{\partial UE} < 0 \quad \frac{\partial IE}{\partial EF} < 0 \quad \frac{\partial IE}{\partial VAR(EF)} > 0.$$

E. Summary

The preceding sections have outlined interrelationships among the endogenous variables of our analysis: (1) accidents, (2) noncompliance, and (3) enforcement. The arguments have indicated the importance of distinguishing between hazardousness and noncompliance in order to examine OSHA effects; specifically, enforcement has no direct effect on accidents but rather operates through its impact on noncompliance. Firms have an incentive to adjust their compliance levels in response to OSHA enforcement efforts and the level of compliance affects workplace safety. An important result is that these effects on noncompliance will vary systematically across firms because of cost asymmetries in regulatory burdens. Union practices and economies of scale in compliance provide the principal sources of expected cost asymmetries within industries. The effects of these cost asymmetries are shown to be exacerbated by enforcement asymmetries predicted by the economic theory of regulation—that is, the concentration of inspections on small, nonunion firms.

In sum, we have shown that an empirical study of OSHA's impact requires a three-equation model of accidents, noncompliance, and enforcement. In the next section we discuss the data and empirical specifications.

III. Empirical Specifications and Data Sources

A. Introduction

Data for our study are subject to four important limitations. First, our analysis considers only workplace safety; all health related data are purged from our sample. Only safety inspections, violations of safety standards, and occupational injuries are included; health regulations and occupational illnesses are ignored. The link between occupational illness and workplace characteristics is very difficult to establish because of time lags and multiple causations of illness, and therefore we believe it appropriate to focus on OSHA activities that pertain to occupational injuries. Inasmuch as the vast majority of all lost workdays are accounted for by injuries (97 percent in 1977) and the vast majority of OSHA inspections have been performed by safety inspectors, the exclusion of health variables should not be viewed as overly restrictive. Secondly, data are restricted whenever possible to firms located in the twenty-two states where safety regulations have been directly enforced by OSHA during the entire 1972–79 period.[12] Under provisions of the Occupational Safety and Health Act of 1970, states may retain responsibility for development and enforcement of OSHA standards. State standards must be "at least as effective" as national standards, and adequate personnel must be assigned to enforcement. The agency must delegate regulatory authority to those states submitting an acceptable program to the U.S. secretary of labor, whereupon the Department of Labor may reimburse up to 50 percent of state administrative and enforcement costs. Unfortunately, there are substantial differences in the relative vigor of federal and state enforcement efforts. Data provided by OSHA for this study indicate that federal inspectors each visit 60 percent more workers than do state inspectors, that federal inspectors are almost three times as likely as state inspectors to cite firms with serious violations, and that federal fines per violation *within* comparable classes of violation are almost twice the rate assessed at the state level. In the light of these profound differences between federal and state jurisdictions we have elected to concentrate on those states subject to the more vigorous federal enforcement.

The third restriction on our study was imposed by limited availability of key variables outside the mid-seventies. In particular, the data set needed to calculate average firm size for industries in the twenty-two states started in 1974. Further, the latest data available for the calculation of the injury rate variable for industries in the twenty-two states were for the year 1978. Accordingly, our analysis is restricted to the time period 1974–78. The fourth restriction is to three-digit SIC manufacturing industries, since many of the key variables were not available outside the manufacturing sector. It should be noted that approximately 50 percent of OSHA inspections were conducted in the manufacturing sector.

We now turn to a discussion of each of the equations in our model, beginning with the accident equation and followed by the compliance and enforcement equations. In the last section, a summary of the three-equation model is provided.

[12] Actually twenty-one states—Alabama, Arkansas, Delaware, Florida, Georgia, Idaho, Kansas, Louisiana, Maine, Massachusetts, Mississippi, Missouri, Nebraska, New Hampshire, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Dakota, Texas, and West Virginia—and the District of Columbia.

B. Injury Rate Equation

The injury rate is defined as lost workdays per 100 full-time workers (*AE*) and was obtained from a special data set tabulated by the Bureau of Labor Statistics and restricted to firms in the relevant twenty-two states.[13] According to equation (1), the injury rate is a function of the level of violations of OSHA standards as well as the vector **H**, which measures determinants of the industry's natural hazardousness. We will defer our discussion of the empirical measure of violations to the next section and proceed to describe the vector **H**. In enumerating the elements of **H**, our discussion relies, in part, on the industrial safety literature which is best summarized in Oi's 1974 survey article.[14]

Oi has shown that the relationship between the injury rate (*AE*) and firm size (*EF*) is an inverted U. This is because in small firms there is close supervision by the managers, which reduces worker injuries, while in very large firms economies of scale in the use of professional safety staffs reduce injury rates below the levels experienced in midsize firms. The functional form we use to estimate this relationship is

$$\ln(AE) = \alpha(EF) + \beta \ln(EF), \tag{8}$$

where $\alpha < 0$ and $\beta > 0$. Note that the ratio $(-\beta/\alpha)$ gives the firm size at which the injury rate is maximized. Average firm size in the industry is estimated from the Census Bureau's *County Business Patterns* tapes.[15]

[13] The variable used for the accident rate (lost workdays per worker) combines both frequency and severity aspects of injuries. An alternate variable (lost workday cases per worker) measures only the frequency of injuries and has at times been used in empirical studies of OSHA. We also estimated our model using this latter variable and found that our results were unchanged.

[14] Walter Oi, On the Economics of Industrial Safety, 38 Law and Contemp. Probs. 669 (1974).

[15] These tapes provide data on the number and size distribution (by employees) of establishments for each three-digit SIC industry for the relevant twenty-two states. Because of data limitations, the number of employees in each industry and year had to be estimated using the following formula:

$$\sum_{i=1}^{7} F_i M_i,$$

where F_i = number of establishments in size class i and M_i = average ratio of workers to establishments in size class i. For the largest size class (more than 1,000 workers in each establishment), we assumed that M_i equaled the average number of employees in national firms of comparable size in the same industry. Note that M_i is constant across all industries except in the largest size class. The national average firm size for the largest size class, which varies by industry, was obtained from the published volumes of County Business Patterns.

Adhering to previous research, we also use the following variables in the injury rate equation: the percentage of production workers (*PROD*), percentage of male workers (*MALE*), the new hire rate (*NHR*), average overtime hours (*OVER*), percentage of unionized workers (*UE*), percentage of professional employees (*PROF*), average education (*EDUC*), and the labor/capital ratio as measured by the ratio of labor costs (salaries plus fringes) to the value of shipments in the industry (*LCR*). The first five variables are obtained from the *Employment and Earnings* files of the Bureau of Labor Statistics, the next three are from the *Current Population Survey*, and the last is from the Census Bureau's *Annual Survey of Manufactures*. We also use the rate at which workers complain to OSHA about job hazards (*CE*).[16]

Finally, an analysis of worker injuries must take account of the role played by the workers' compensation system. The benefit structure varies across states and over time, and previous research by Butler and Worrall has shown that reported injury rates are higher in those locations and those years when benefit formulas are the most liberal.[17] Two variables are used to capture variations in the workers' compensation program. The first is the expected benefit variable that was constructed by Butler and Worrall. It is calculated for each of the twenty-two states in each of the years 1974–78 and is an expected (as opposed to the actual) benefit measure for a representative wage earner with a spouse and two children who files a claim for a temporary total disability.[18] An expected benefit measure (*BEN*) is created for each of the three-digit industries by calculating a weighted average of the Butler-Worrall variables using the geographic distribution of the employees in the industry as the weights. A second measure of variations in the workers' compensation program is a weighted average of the waiting period (*WAIT*) for receipt of benefits, again using the geographic distribution to create the weights.

C. *Industrial Compliance with OSHA Standards*

Since the unit of analysis is an industry, we might use total industry violations divided by the number of firms in the industry as a measure of violations per firm in that industry. Note, however, that violations per

[16] We recognize that the relationships among the injury rate and percentage unionized, the labor/capital ratio, and the worker complaint rate may be simultaneous, but we treat the latter three variables as exogenous to our model.

[17] Richard J. Butler & John D. Worrall, Workers' Compensation: Benefit and Injury Claims Rates in the Seventies, 65 Rev. Econ. and Statis. 580 (1983).

[18] Actual benefits should not be used because that would create a tautological relationship between injury rates and benefits.

firm are not directly observable. Violations of OSHA standards are much like victimless crimes in that they are not automatically reported, but rather must be uncovered and verified by inspections. Not violations per firm (VF) but only registered violations (R) generated by inspections (I) are observable. The variables are related as follows:

$$R = VF \cdot I. \tag{9}$$

Hence registered violations per inspection (observed noncompliance) is a proxy for violations per firm (actual noncompliance).

An additional complexity arises in that OSHA registers several levels of violations of varying severity. For example, in the first quarter of 1979, nonserious violations received average penalties of $3, serious violations and nonserious failure-to-abate notices received average penalties of $450, repeat violations $550, serious failure-to-abate notices $2,000, and willful violations $5,500.[19] We have chosen to aggregate these numerous classes of violations by using penalties per inspection. This penalty variable represents, in effect, a weighted average of noncompliance rates (per firm) for each industry; note that this variable measures noncompliance, not enforcement, since heterogeneous industries are confronting a uniform penalty regime with each industry choosing its extent of noncompliance. Finally, since our model uses violations per employee as the relevant measure of noncompliance, we divide the penalty variable by average firm size, EF, to create the empirical proxy for VE, which we name PIE.

The data in Table 1 provide summary statistics on the penalty variable and other relevant variables from the OSHA Management Information Systems (MIS) data set. In examining Table 1, note that the 1972 data only refer to enforcement activity for the last six months of the year since records of activities during the first half of the year were not maintained. As Table 1 demonstrates, the annual number of OSHA inspections peaked in 1974 and by 1979 had declined to half that level. As columns 2–4 show, however, total penalties, and, therefore, average penalties per inspection and average penalties per violation, rose consistently between 1974 and 1978. The explanation for this upward trend in penalties can be seen in column 5, if we remember that violations classified as serious receive dramatically larger penalties than violations classified as nonserious. Beginning in 1976, OSHA upgraded a large number of violations from the nonserious status to the serious status; in addition, firms with ten or fewer nonserious violations were exempt from any penalties. As col-

[19] See Occupational Safety and Health Administration, MIS Report No. SP03 (May 22, 1979).

TABLE 1

OSHA INSPECTIONS AND PENALTIES IN MANUFACTURING FIRMS LOCATED IN FEDERALLY ENFORCED STATES*

	Total Inspections	Total Penalties ($)	Average Penalty per Inspection ($)	Average Penalty per Violation ($)	Proportion of Violations That Are Serious	Compliance Rate (%)†	ρ‡
1972	2,858	318,176	111	25.1	.01	39.8%	1.97
1973	13,106	1,193,086	91	22.3	.01	37.5	1.75
1974	23,657	1,610,655	68	12.7	.01	43.5	1.00
1975	21,682	2,053,877	95	15.7	.02	42.6	1.235
1976	15,838	2,307,815	146	23.6	.05	42.0	1.85
1977	14,536	2,966,755	204	44.6	.18	56.9	3.5
1978	11,960	3,884,009	325	89.8	.27	62.1	7.05
1979	11,101	3,410,918	307	93.6	.30	57.1	7.35

* Safety-related inspections and penalties only. All penalty data are in constant dollars using 1972 as the base.
† Percentage of inspections where no violations were uncovered.
‡ See text for definition.

umn 5 shows, prior to 1977, between 1 percent and 5 percent of recorded violations were serious while in 1977 the proportion rose to 18 percent and continued to rise to 27 percent in 1978 and 30 percent in 1979. It is this shift in policy that is responsible for the artificial inflation in the average penalty per inspection in recent years. Note from the trend in the compliance rate that the upward trend in penalties per inspection is not due to a surge of actual noncompliance.

The agency's reclassification of violations creates a problem for estimating the model in a pooled cross-section time-series framework, in that penalties per inspection must be converted to a common base. We do this by redefining the penalty variable as $((PIE/\rho) + \beta)$. We calculate ρ for each year by dividing the average penalty per violation in that year by the average penalty per violation in 1974. The calculated values for ρ are shown in column 7 of Table 1. This corrects for the upgrading of some nonserious violations to the serious category. In addition, we set $\beta = 40$ for 1976, 1977, and 1978, because beginning in 1976 Congress authorized OSHA to exclude penalties for nonserious violations in cases where there were ten or fewer of these violations. Hence, since firms which fell into this category had, on average, five nonserious violations, each with an average penalty of $8, the intercept of the penalty equation must be moved.[20]

The probability of an OSHA inspection is measured by the ratio of total inspections in the industry to the number of workers in the industry: ρ is also used as an independent variable in the equation in order to measure the compliance effect of a change in the penalty structure. Another measure of OSHA's enforcement efforts is its use of failure-to-abate (FTA) penalties, which are very large penalties assessed against firms that do not move into compliance after an inspector has issued a citation. We expect that firms that had a high ratio of FTA penalties to general penalties in the previous period are more likely to be in compliance this period.

As proxies for the marginal cost of noncompliance, we use the injury rate (*AE*), the complaint rate (*CE*), the percentage of penalties remitted (*REMIT*)[21] and dummy variables for the primary metals, paper mills, and chemicals industries (*PMETAL, PMILL,* and *CHEM*), which are found to have significantly high compliance costs in the Business Roundtable's 1979 report on the cost of government regulation.[22] Average firm size and

[20] β is set equal to one for 1974 and 1975 in order to avoid taking the logarithm of zero.

[21] Industries that find it difficult to comply will be more likely to contest fines and thus less likely to remit the assessed penalties.

[22] Arthur Andersen & Co., Cost of Government Regulation Study for the Business Roundtable (1979).

unionization are also included in the equation and their coefficients will be negative if there are compliance asymmetries.

Finally, our model of the firm's compliance decision assumes that each period the firm decides whether or not to come into compliance with OSHA's standards. Since these standards are specifications that relate to the firm's capital stock, compliance in one period is likely to affect compliance in subsequent periods; that is, if the firm modifies its equipment in order to achieve compliance, that modification is likely to be permanent. Therefore, last period's violation rate is included as a determinant of this period's violations.

D. Inspection Equation

The following variables are used in this equation: average firm size, the variance of firm size, the lost workday rate (*AE*), average hourly earnings (*HREARN*), profits (*PRFT*) which are defined as (value added − labor costs)/assets and are calculated from the *Annual Survey of Manufacturers,* the penalty variable (*PIE*), the percentage of unionized employees (*UE*), and the rate at which workers complain to OSHA about hazards (*CE*).[23] Additionally, two time interaction terms were added for average firm size and the variance of firm size. These interaction terms capture the successful mounting of pressure from small businesses against OSHA in Congress.[24] Note that as enforcement asymmetries against small firms decline to zero due to this pressure, the effects of average firm size and the variance of firm size should simultaneously approach zero.

An interesting prediction about the coefficient on *CE* derives from OSHA's claim that it responds to virtually every complaint by conducting an inspection. If this is true, then note that

$$\epsilon(IE, CE) = \frac{C}{I} + \frac{I - C}{I}\,\epsilon\left(\frac{I - C}{F}, CE\right), \tag{10}$$

where C/I = proportion of complaint inspections and $\epsilon(a, b)$ denotes the elasticity of a with respect to b. If OSHA does not adjust noncomplaint inspections in response to the complaint rate, then $\epsilon(IE, CE)$ will equal the proportion of complaint inspections. If instead other inspections increase with the complaint rate, then $\epsilon(IE, CE)$ will be larger; compensating decreases in other inspections will make $\epsilon(IE, CE)$ smaller than C/I.

[23] Many critics of OSHA have regarded the complaint rate as merely a measure of union harassment of management, especially during strikes. We must stress that the simple correlation between *CE* and *UE* is only .36, and that *CE* is quite significantly related to both accident rates and noncompliance rates. Hence, *CE* is not a proxy for *UE*.

[24] For evidence of small business pressure against OSHA, see Kelman, *supra* note 5.

Further, note that the proportion of complaint inspections has been increasing steadily from 5 percent in 1974 to 30 percent in 1978; hence we add an interaction term $CE^*(YEAR - 74)$ to capture the expected upward drift in this coefficient.

E. Summary

The structural equations for accidents, industrial noncompliance, and OSHA enforcement are given below. A complete glossary of variables is given in Table 2 and predicted signs are indicated in parentheses underneath each variable. This system of equations, which was derived in Section II, indicates the interrelationships among the endogenous variables of our analysis. Two points regarding this system are worth emphasizing. First, it shows the importance of distinguishing between hazardousness and noncompliance in order to examine OSHA impacts; specifically, enforcement has no direct effect on accidents (equation [11]) but rather operates through its impact on noncompliance (equation [12]). Second, the system demonstrates the role of indirect effects of regulation; they are shown to arise in equation (12) through cost asymmetries in regulatory burdens and are manifested in equation (13) as enforcement asymmetries.

$$
\begin{aligned}
\ln(AE) = {} & \gamma_0 + \underset{(+)}{\gamma_1 \ln(PIE)} + \underset{(+)}{\gamma_2 \ln(EF)} + \underset{(-)}{\gamma_3 EF} + \underset{(+)}{\gamma_4 \ln(CE)} \\
& + \underset{(+)}{\gamma_5 \ln(PROD)} + \underset{(+)}{\gamma_6 \ln(MALE)} + \underset{(-)}{\gamma_7 \ln(PROF)} + \underset{(+)}{\gamma_8 \ln(UE)} \\
& + \underset{(-)}{\gamma_9 \ln(LCR)} + \underset{(-)}{\gamma_{10} \ln(EDUC)} + \underset{(+)}{\gamma_{11} \ln(NHR)} \\
& + \underset{(+)}{\gamma_{12} \ln(OVER)} + \underset{(+)}{\gamma_{13} \ln(BEN)} + \underset{(+)}{\gamma_{14} \ln(WAIT)} \\
& + \gamma_{15} REGION + \gamma_{16} YRDUM + \epsilon_1
\end{aligned}
\tag{11}
$$

$$
\begin{aligned}
\ln(PIE) = {} & \beta_0 + \underset{(-)}{\beta_1 \ln(IE)} + \underset{(-)}{\beta_2 \ln(\rho)} + \underset{(-)}{\beta_3 \ln(1 + FTA)} + \underset{(+)}{\beta_4 \ln(AE)} \\
& + \underset{(+)}{\beta_5 \ln(EF)} + \underset{(-)}{\beta_6 \ln(CE)} + \underset{(+)}{\beta_7 \ln(REMIT)} + \underset{(+)}{\beta_8 PMETAL} \\
& + \underset{(+)}{\beta_9 CHEM} + \underset{(+)}{\beta_{10} PMILL} + \underset{(+)}{\beta_{11} \ln(UE)} + \underset{(+)}{\beta_{12} \ln(PIE)_{-1}} \\
& + \beta_{13} YRDUM + \epsilon_2
\end{aligned}
\tag{12}
$$

TABLE 2
KEY TO VARIABLES

Variable Name	Definition
AE	Lost workdays per worker
BEN	Expected workers' compensation benefit (see text)
CHEM	Dummy variable for chemicals industries
CE	Complaints per employee *CEYR* = *CE**(*YEAR* − 74)
*D*302	Dummy variable for SIC302—rubber and plastics footwear
DC	Percentage of industry employees in the District of Columbia
EDUC	Average education of employees
EF	Employees per firm *EFYR* = *EF**(*YEAR* − 74)
FTA	Ratio of failure to abate penalties to other penalties in the previous period
HREARN	Average hourly earnings
IE	Inspections per worker
LCR	Labor cost ratio = labor costs/value of shipments
MALE	Percentage male employees
NHR	New hire rate
OVER	Average weekly overtime hours
PIE	Penalties per inspection/employees per firm
PMETAL	Dummy variable for primary metals industries
PMILL	Dummy variables for paper mills industries
PRFT	(Value added minus labor costs)/assets
PROD	Percentage production workers
PROF	Percentage professional employees
REGION	Vector of regional dummies
REMIT	Ratio of penalties remitted to penalties assessed
ρ	See text
UE	Percentage of employees that are unionized
VAR	Variance of firm size
VARYR	*VAR**(*YEAR* − 74)
WAIT	Expected waiting period for workers' compensation benefits (see text)
YRDUM	Dummy variables for the various years

$$\begin{aligned} \ln(IE) = {} & \alpha_0 + \underset{(?)}{\alpha_1 \ln(PIE)} + \underset{(-)}{\alpha_2 \ln(EF)} + \underset{(+)}{\alpha_3 [\ln(EF) \cdot (YEAR - 74)]} \\ & + \underset{(+)}{\alpha_4 VAR} + \underset{(-)}{\alpha_5 [VAR \cdot (YEAR - 74)]} + \underset{(+)}{\alpha_6 \ln(AE)} \\ & + \underset{(+)}{\alpha_7 \ln(HREARN)} + \underset{(+)}{\alpha_8 \ln(1 + PRFT)} + \underset{(-)}{\alpha_9 \ln(UE)} \\ & + \underset{(+)}{\alpha_{10} \ln(CE)} + \underset{(+)}{\alpha_{11} [\ln(CE) \cdot (YEAR - 74)]} + \alpha_{12} YRDUM + \epsilon_3. \end{aligned} \tag{13}$$

IV. RESULTS

Equations (11)–(13) are estimated on pooled cross-section time-series data in which the unit of observation is a three-digit SIC manufacturing industry in each of the years 1974 through 1978. The estimation technique is two-stage least squares.

A. *Injury Rate Equation*

The results of estimating equation (11) are shown in Table 3. The major finding in Table 3 is the positive coefficient on the penalty variable, *PIE*, which is significant only at the 10 percent level using a one-tailed test. The coefficient itself implies that if all firms moved into complete compliance, then injury rates would fall by 9.8 percent. The fact that the coefficient is only marginally significant lends support to the inefficacy hypothesis, which argues that there is only a weak linkage between noncompliance with OSHA standards and workplace accidents. This finding is also consistent with an earlier study done by engineers in the California Division of Industrial Safety.[25] In that study, which was restricted to workplaces in California, the conclusion was that only 19 percent of workplace injuries could have been prevented by a fully effective government safety program.

The remaining coefficients in Table 3 are all consistent with predictions and with the findings in the industrial safety literature summarized in Oi's1974 survey article.[26] The relationship between the injury rate and firm size is an inverted U with a peak at approximately 160 workers. Also, injury rates are positively correlated with percentage production workers, percentage male employees, the new hire rate, percentage unionized, and the worker complaint rate. They are negatively correlated with the education of employees, percentage professional employees, and the labor/capital ratio. Finally, one aspect of the workers' compensation program is found to be an important determinant of reported injury rates: as the waiting period for benefits decreases, reported injury rates rise significantly.

B. *Noncompliance Equation*

The results of estimating equation (12) are shown in Table 4. The major finding in Table 4 is the negative and significant coefficient on the inspection probability, *IE*, indicating the responsiveness of firms' compliance decisions to OSHA's enforcement efforts. Using the fact that lagged penalties are included in the equation, the coefficients indicate that the long run effect of a doubling of the inspection rate is to raise compliance

[25] Mendeloff, An Evaluation of the OSHA Program's Effect on Workplace Injury Rates, *supra* note 1.

[26] Oi, *supra* note 14.

TABLE 3

DEPENDENT VARIABLE: Ln(Lost Workdays per Worker)

Independent Variable*	Coefficient	*t*-Value
PIE	.093	(1.46)
Ln(*EF*)	.208	(3.37)
EF	−.0014	(−5.77)
PROD	.804	(9.99)
MALE	.880	(14.24)
UE	.099	(4.03)
PROF	−.105	(−2.70)
WHITE	−.474	(−3.21)
LCR	−.104	(−3.50)
CE	.080	(3.77)
EDUC	−.694	(−2.79)
NHR	.086	(1.45)
OVER	.058	(1.20)
BEN	.346	(.81)
WAIT	−.578	(−2.41)
*D*74	−.174	(−2.14)
*D*75	−.069	(−1.04)
*D*76	−.041	(−.83)
*D*77	−.044	(−1.20)
Constant	9.44	(4.83)
R^2	.79	

* All variables except *EF*, *D*74, *D*75, *D*76, and *D*77 are in logs. This equation also contains a vector of regional dummies.

TABLE 4

DEPENDENT VARIABLE: Ln(Penalties per Inspection/Employees per Firm)

Independent Variable*	Coefficient	*t*-Value
IE	−.209	(−3.92)
ρ	−.458	(−7.02)
FTA	−.098	(−1.07)
EF	−.929	(−35.80)
UE	.003	(.11)
AE	.235	(5.53)
CE	.220	(6.57)
REMIT	−.332	(−6.35)
PMETAL	.347	(4.14)
PMILL	.393	(4.33)
CHEM	.257	(2.42)
PIE(−1)	.193	(7.23)
*D*74	−.376	(−3.40)
*D*75	−.116	(−1.16)
*D*76	.128	(1.81)
Constant	2.55	(5.92)
R^2	.86	

* All variables except *PMETAL*, *PMILL*, *CHEM*, *D*74, *D*75, and *D*76, are in logs.

by 25.8 percent. Noncompliance is also strongly affected by increases in the penalty structure as measured by the variable ρ, whose coefficient is negative and very significant. Indeed, increases in the penalty structure are a more efficacious means of achieving greater compliance than increases in inspection rates. Hence we have quite strong evidence that the noncompliance hypothesis is false. It is revealing to note, however, that according to the coefficients in Table 3, the result of a doubling of the inspection rate is only a 2.5 percent reduction in the lost workday rate because of the weak relationship between compliance and safety.

Table 4 also reports findings on the existence of hypothesized compliance asymmetries due to unionization and firm size. Note that there are no significant violation rate differences due to unionization, indicating that the marginal costs of compliance are not related to unionization.[27] Large firms, however, clearly choose lower violation rates because of lower marginal costs of compliance. These findings demonstrate the presence of significant economies of scale in compliance for large firms and, therefore, the opportunity for redistributions of wealth from small to large firms through OSHA enforcement.

Finally, as explained in Section III, several variables are used to proxy the marginal cost of compliance and all these variables have the expected effects. Note that compliance is lower in those industries with high lost workday rates, high worker complaint rates, and low percentages of penalties remitted. Furthermore, the industries singled out by the Business Roundtable report on the costs of government regulation—primary metals, paper mills, and chemicals—have significantly higher penalty rates.[28]

C. *Inspection Equation*

Estimates for the inspection equation (13) are given in Table 5. The results are consistent with the predictions derived from the model of enforcement used in Section II. First, note that the effect of noncompliance, *PIE*, is statistically insignificant, because, as explained earlier, there are offsetting satiation and productivity effects. The satiation effect occurs because greater natural noncompliance lowers marginal net political support, thus decreasing the politically optimal inspection rate. At the

[27] However, in an analysis of corporate investments in safety equipment, we found statistically significant compliance asymmetries due to unions. See Ann P. Bartel & L. G. Thomas, The Costs and Benefits of OSHA-induced Investments in Employee Safety and Health, in Benefit Issues in Workers' Compensation (John D. Worrall ed. 1985).

[28] Andersen & Co., *supra* note 22.

TABLE 5
DEPENDENT VARIABLE: Ln(Inspections per Worker)

Independent Variable*	Coefficient	*t*-Value
PIE	.076	(.97)
AE	.525	(9.91)
PRFT	.305	(3.55)
HREARN	.215	(.59)
EF	−.596	(−8.37)
EFYR	.151	(10.58)
VAR	.263	(2.51)
VARYR	−.071	(−1.72)
UE	−.106	(−3.83)
CE	.148	(3.94)
CEYR	.139	(10.22)
DC	−3.41	(−4.93)
*D*302	2.58	(11.23)
*D*74	−.534	(−1.16)
*D*75	−.100	(−.29)
*D*76	−.297	(−1.32)
*D*77	−.154	(−1.30)
Constant	−5.95	(−2.64)
R^2	.84	

* All variables except *D*302, *D*74, *D*75, *D*76, and *D*77 are in logs.

same time, however, inspections are more productive, because they produce a larger wealth transfer and the optimal inspection rate rises.

Second, the anticipated wealth effects are indeed present; industries with higher injury rates (holding constant compliance levels) and industries with higher profit rates are inspected more frequently. The hourly earnings variable has the correct sign but is not significant.

Third, the results confirm the existence of organizational effects that give rise to enforcement asymmetries. Note that unionization has a negative and significant coefficient; this implies that unionized firms use OSHA as a tool for imposing costs on nonunionized firms.[29] In addition, industries with larger average firm sizes have lower inspection rates, although this enforcement asymmetry disappears by 1978. Further, consis-

[29] Confirmation of this finding can be found by examining other OSHA enforcement activities. For example, a logit analysis of OSHA decisions to include or exclude a three-digit SIC industry in the Target Industry Program (TIP) which was the highlight of OSHA enforcement efforts in 1972 yields the following estimates:

$$\underset{}{TIP} = \underset{(-1.62)}{-.627} + \underset{(3.01)}{.11\ \ln(AE)} - \underset{(-3.20)}{.041\ UE} - \underset{(-1.40)}{.008\ \ln(EF)}.$$

tent with the existence of mean firm size effects, the predicted variance effects exist and disappear by 1978.

These findings confirm that indirect effects of regulation can arise in two ways. First, different marginal costs of compliance can cause some firms to suffer higher regulatory burdens even when regulations are uniformly enforced. An example of this compliance asymmetry (only) is provided by small firms in 1978. Alternately, even when no compliance asymmetry exists, indirect effects can be created through more vigorous enforcement against selected firms, as occurred in the case of nonunion firms throughout the sample period. Of course, both compliance asymmetry and enforcement asymmetry may exist, combining to doubly disadvantage targeted firms, as was the case with small establishments in 1974.

As regards other variables, the coefficients on the worker complaint variables *CE* and *CEYR* show that inspections, including noncomplaint inspections, are responsive to the complaint rate. We reach this conclusion because the elasticity of the inspection rate with respect to the complaint rate exceeds the proportion of complaint inspections (see our discussion of equation [10]). Second, the inspection rates in the District of Columbia are found to be significantly lower than outside.[30] Finally, the positive and significant coefficient on the dummy variable for SIC 302, rubber and plastics footwear, indicates an extraordinarily high inspection rate for this industry, which cannot be explained by the variables in our model.

V. Conclusions

This study has developed and tested a three-equation model of workplace injuries, industrial noncompliance with OSHA safety standards, and OSHA enforcement. Two sets of policy conclusions arise from this research.

First, previous work has advanced two hypotheses to explain OSHA's apparent failure to reduce workplace injury rates. These are (1) the noncompliance hypothesis, which argues that because of limited statutory and budgetary authority from Congress, OSHA is unable to compel industrial compliance with its own standards, and (2) the inefficacy hypothesis, which argues that the Act itself is flawed because it emphasizes standards for capital equipment when most accidents in fact are caused by complex epidemiological interactions of labor, equipment, and the workplace envi-

[30] Distinguishing the District of Columbia from other locations was also found to be important in a study of wage determination in the federal government. See George J. Borjas, Wage Determination in the Federal Government: The Role of Constituents and Bureaucrats, 88 J. Pol. Econ. 1110 (1980).

ronment. Our study has found only weak linkages between noncompliance and workplace accidents, indicating that the inefficacy hypothesis is largely correct, although the statement that OSHA standards achieve no reductions at all in injuries is probably invalid. In contrast, there are significant effects of OSHA enforcement on industry violation rates, indicating that the noncompliance hypothesis is false. From a policy perspective then, continued enforcement of existing safety standards by OSHA can produce at best an extremely minimal effect on workplace injury rates. Note that we do not examine and hence draw no conclusions on the efficacy of OSHA health regulations.

The second conclusion of this research suggests a resolution of the paradox of why OSHA regulations were supported and funded by Congress throughout the 1970s when OSHA standards produced few direct benefits but significant costs. An answer suggested by this study is that, in concentrating on the direct effects of regulation, past research has been misguided; indirect effects of OSHA regulations exist, are significant in magnitude, and may well dominate any direct effects (certainly direct benefits). The apparent beneficiaries of these indirect transfers of wealth are unionized and large firms, who would reasonably provide political support for the agency, so long as OSHA has some cost impact—and so long as this impact is asymmetrically distributed against nonunion and small firms.

In focusing on the distinction between direct and indirect effects of regulation, we have shown that OSHA regulations have complex effects on the economy that cannot simply be understood in the context of a "direct effects" model. We believe that this approach can and should be applied to the study of the enforcement policies and impacts of other regulatory agencies.