77-8516

HENDERSON, David Richard, 1950-
THE ECONOMICS OF SAFETY LEGISLATION
IN UNDERGROUND COAL MINING.

University of California, Los Angeles,
Ph.D., 1976
Economics, general

Xerox University Microfilms, Ann Arbor, Michigan 48106

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1977

UNIVERSITY OF CALIFORNIA

Los Angeles

The Economics of Safety Legislation in Underground Coal Mining

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Philosophy in Economics

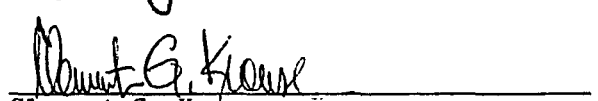
by

David Richard Henderson

1976

The dissertation of David Richard Henderson is approved.

Benjamin Klein



Clement G. Krouse

Harold Demsetz, Committee Chairman

University of California, Los Angeles

1976

TO HARRY

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ACKNOWLEDGMENTS

I would like to acknowledge my debt to Ayn Rand, whose novels significantly affected my Weltanschauung and sparked my interest in libertarianism and economics, to my friend Clancy Smith, who taught me how to think rigorously and heightened my interest in the world of the intellect, to Harold Demsetz, who, in 1970, when my interest in economics was flagging, convinced me that economics had much to say about the real world, and to Armen Alchian and Sam Peltzman, who made my first year at UCLA exciting, the former of whom (whatever his intent) taught me that economics is not a career but a calling.

I am grateful also to Ken Gaver, Clem Krause, Bill Meckling, Walter Oi, Tom Russell, and Fred Thomas for helpful discussion at various stages. I would have had a much tougher time if not for the moral support given by many of my friends, especially, Bob Barro, Jane Goldman, Mike Jensen, Sam Kazman, Chrissy Morganello, and Tom Nagle.

Finally, I would like to acknowledge financial aid from the Canadian taxpayers, who were forced to support the early stages of my research via the Canada Council and to the Center for Research in Government Policy and Business at the University of Rochester, which financed the final stages of the dissertation.

VITA

November 21, 1950--Born, Boissevain, Manitoba, Canada

1970--B.Sc., University of Winnipeg

1972-1974--Teaching Assistant, Department of Economics, University of California, Los Angeles

1974--M.A., University of California, Los Angeles

1975-1976--Assistant Professor, Graduate School of Management, University of Rochester

PUBLICATIONS

HENDERSON, DAVID RICHARD (joint with PRIME, MICHAEL GEORGE).
1975 Schumpeter on Preserving Private Enterprise. History of Political Economy 7 (Fall 1975): pp. 293-298.

HENDERSON, DAVID RICHARD.
1977 "Land Reform and Agricultural Efficiency in Mexico: A Comment," in Karl Brunner and Allan H. Meltzer, eds., Proceedings of the Carnegie-Rochester Public Policy Conference 6 (Amsterdam: North-Holland Publishing Co., forthcoming).

ABSTRACT OF THE DISSERTATION

The Economics of Safety Legislation

in Underground Coal Mining

by

David Richard Henderson

Doctor of Philosophy in Economics

University of California, Los Angeles, 1976

Professor Harold Demsetz, Chairman

This study examines the case for government intervention in the safety decisions of workers and firms in the presence of imperfect information about job risk, labor market monopoly, and economies of scale in safety production, and finds the case for government intervention weak. It then proceeds to examine the effects of federal safety legislation in underground coal mining passed by Congress in 1952, 1966 and 1969.

Data used are taken from annual reports of state mineral departments, Information Circulars published by the Bureau of Mines, Minerals Yearbooks, Bureau of Labor Statistics Bulletins, and the Center for Research in Securities Prices (CRSP) tape. The data are on the output and price of coal, manhours spent producing coal, fatal and non-fatal injuries incurred in the production of coal, wages of coal miners, numbers of mines in various labor force size categories, and rates of return on coal mining firms whose stocks were traded on the New York Stock Exchange.

The findings are: (1) that the 1952 Act had no effect on injuries but did result in a shift of production from the unregulated to the regulated coal mining sector, (2) that the 1966 Act had some salutary effect on injuries but that it resulted in the elimination of many small mines, (3) that the 1969 Act had no effect on fatal injuries, furthered the elimination of small mines, and resulted in a significantly higher cost of producing coal and a significantly higher price of coal, (4) that most of the small mines eliminated by the 1966 Act were predominantly non-union mines, (5) that the role of the United Mine Workers (UMW) and the large unionized mines in lobbying for the 1966 and 1969 legislation can be understood in light of the fact that the legislation eliminated small non-union mines, and (6) that the royalty rate per ton of coal paid by unionized mining firms to the United Mine Workers Welfare and Retirement Fund can best be viewed as a device to help achieve the monopoly output in coal mining.

CHAPTER I

INTRODUCTION

> The maxim that governments ought to train the people in the way in which they should go sounds well. But is there any reason for believing that a government is more likely to lead the people in the right way than the people to fall into the right way of themselves?
>
> --Thomas Babington Macaulay, "Southey's Colloquies on Society," in Critical and Historical Essays 1 (London: Longmans, Green, and Company, 1890), p. 243.

Until recently, there has been little examination of either the case for government intervention in the safety decisions of firms and workers or of the effects of actual government regulation of safety.[1] This study represents a contribution to the literature on both these issues. The underground sector of the coal mining industry is an appropriate area for the study of regulation since explicit government regulation in safety has been longer-lived there than in most other industries. A critical analysis of the case for government intervention with special reference to the underground coal mining industry is presented in Chapter II. The effects of actual government intervention are studied in Chapters III and IV. Finally various hypotheses about the motivation of the interested parties are tested in Chapter V. Lastly, the findings of the study are summarized in Chapter VI.

FOOTNOTES

1. But see, James R. Chelius, "The Control of Industrial Accidents: Economic Theory and Empirical Evidence," Law and Contemporary Problems (Summer/Autumn 1974): 700-729; Walter Y. Oi, "On the Economics of Industrial Safety," Law and Contemporary Problems (Summer/Autumn 1974): 669-699; Walter Y. Oi, "On Evaluating the Effectiveness of the OSHA Inspection Program," (unpublished manuscript, University of Rochester, 1975); Robert S. Smith, "The Feasibility of an Injury Tax Approach to Occupational Safety," Law and Contemporary Problems (Summer/Autumn 1974): 730-744; and, Robert S. Smith, The Occupational Safety and Health Act (Washington, D.C.: American Enterprise Institute, 1976).

CHAPTER II

POSSIBLE JUSTIFICATIONS FOR GOVERNMENT INTERVENTION IN THE SAFETY DECISION IN UNDERGROUND COAL MINING

> First, the wages of labor vary with the ease or hardship, the cleanliness or dirtiness, the honourableness or dishonourableness of employment. Thus in most places, take the year round, a journeyman taylor earns less than a journeyman weaver. His work is much easier. A journeyman weaver earns less than a journeyman smith. His work is not always easier, but it is cleanlier. A journeyman blacksmith, though an artificer, seldom earns so much in twelve hours as a collier, who is only a laborer, does in eight. His work is not quite so dirty, is less dangerous and is carried on in day-light, and above ground. Honour makes a great part of the reward of all honourable professions. In point of pecuniary gain, all things considered, they are generally underrecompensed, as I shall endeavour to show by and by. Disgrace has the contrary effect. The trade of a butcher is a brutal and odious business; but it is in most places more profitable than the greater part of common trades. The most detestable of all employments, that of public executioner, is, in proportion to the quantity of work done, better paid than any common trade whatever.
>
> --Adam Smith, The Wealth of Nations, ed. Edwin Cannan, 3d ed., Vol I (London: Methuen and Co. Ltd., 1922), p. 102.

> Mr. Boyle, you could do this now, could you not, by agreement with the employees (sic)?
>
> You don't need a law. In other words, if the collective bargaining agreements provide no smoking or open lights, would not that do the job?
>
> --Senator Jacob Javits, in U.S., Congress, Senate, Committee on Labor and Public Welfare, Coal Mine Health and Safety, Hearings before the Subcommittee on Labor, 91st Cong., 1st sess., 1969, p. 474.

Introduction

A number of justifications have been proposed for some form of government intervention in the safety decision of firms and employees.

In this chapter I shall critically analyze these justifications with reference to the underground coal mining industry. I shall restrict the discussion to the arguments which purport to justify government intervention from an efficiency point of view. That is, I shall discuss only arguments which claim that government intervention in the safety decision will improve resource allocation. I shall show that the arguments for government intervention on efficiency grounds are in general weak. Some of the arguments contain non sequiturs. Others are arguments for further intervention to remove distortions caused by past intervention. Finally, one argument for government intervention which I shall discuss requires that the goverment have information which individuals do not have, and which would allow them to reach the optimum if they had it. All the arguments for government intervention require as a necessary condition that government agents have "good intentions." That is, they require that government agents not respond to political incentives. For this reason as well as for other reasons I shall raise, these arguments for government intervention are not satisfactory.

Safety in the Absence of Government Intervention

Before discussing the arguments for government intervention in the private safety decision, I shall analyze the safety decision in the absence of intervention. Although a distinction is often made in the literature[1] between safety and physical health, I shall not make that distinction here. Rather, I shall use the word safety to mean both absence of injury (fatal or non-fatal) and absence of disease from on-the-job causes.

Assume first that there is no government intervention in the safety decision other than to enforce contracts between private parties, that there is perfect information by both workers and employers about the probability of job hazard, that there are no economies of scale in safety production, and that the labor market is perfectly competitive. Assume also that the government does not dictate the assignment of liability for accident costs.[2] The equilibrium amount of safety which results will be such that no potential improvement can be made. The reason is as follows.

If the cost of accident avoidance is lower for employers than for employees, then the employer and employee will agree to hold the employer liable for the accident.[3] Then the employer will bear all the accident costs, including the cost of an injury to the employee or the cost of a bequest to the employee's relatives in the event of death. The employer will consider these costs in deciding how much safety to produce. Since, by hypothesis, there are no economies of scale in safety production, the employer can make a separate safety decision for each of his workers. Of course, to be guaranteed that the employer will make a separate decision for each employee, there must be no economies of scale in contracting. The assumption of no scale economies in contracting can be considered as part of the assumption of no scale economies in safety production.

If the employer is risk neutral, he will produce safety up to the point where the marginal cost of a unit of safety just equals the expected marginal benefits which come in the form of a lower expected damage to equipment and a lower expected injury compensation to a

worker. If the employer is risk averse, he will produce safety beyond this amount. He will be willing to pay a positive amount to avoid risk and will pay this amount in the form of additional expenditures on safety.[4]

In either case the goal of minimizing the sum of accident costs and accident avoidance costs will be achieved.[5] In the case where the employer is risk averse, the cost of risk will be included in the accident costs. No improvement can be made on the outcome in either case.

If the cost of accident avoidance is lower for the worker, on the other hand, then he and the employer will agree in their contract that he will bear the liability for an accident. If the worker is risk neutral, then he will produce safety up to the point where the marginal cost of a unit of safety equals the expected marginal benefits which come in the form of a lower expected compensation payment to the employer for damage to equipment and a lower expected personal loss from injury. If he is risk averse, but not risk averse enough to buy insurance which charges a loading fee, then he will produce safety beyond this point. Just as in the case where the employer bears the liability, the worker will produce safety up to the point where the cost of the marginal unit of safety equals the benefit. In this case the benefit is the decrease in the expected payments for damage to equipment plus the decrease in expected personal losses from an injury plus the value of the decrease in risk. Note that there is no implication for wealth distribution of the assignment of liability since the assignment is voluntarily agreed to by both employer and worker and

is only one of the terms of the contract. Another term of the contract is the pecuniary wage. As Adam Smith pointed out 200 years ago,[6] in the case where the liability in a risky job is borne by the worker (this was implicit in Smith's analysis), the pecuniary wage will compensate.[7]

In both cases, the goal of minimizing the sum of accident costs and accident avoidance costs has been achieved. No improvement can be made on the outcome in either case. Therefore, if the assumptions made to get these results hold, there is no role for government intervention.

However, not all these conditions are likely to hold in the case of underground coal mining. There is no assurance that workers will have perfect information about job hazards in coal mining. There appear to be economies of scale in safety production. For instance, a ventilating fan provides as much safety per worker for ten workers as for nine workers. Finally the labor market in coal mining is not perfectly competitive. A large percent of the labor force is represented by the United Mine Workers union. This union has significant monopoly power.[8] Does the existence of these conditions mean that government intervention is justified? To this issue I now turn. First I shall drop the assumption that workers have perfect information about job hazards.

The Case of Imperfect Worker Information

A standard argument for government intervention in the safety decision has been on the grounds that workers have imperfect information about job hazards. According to this argument, since workers have

imperfect information about job hazards, they will incorrectly evaluate the risk of a given job and will therefore have a supply price for that job which is different from what their supply price would be with perfect information. If workers underestimate the differences in hazards (and therefore differences in safety) across firms, then they will be willing to work for a riskier firm for a wage differential which would not be large enough to attract them if they had perfect information. This will lead to less than optimal safety.

To see this, start with all firms producing the optimal amount of safety and see if this is an equilibrium. Consider two particular firms in this situation. Both firms are producing an amount of safety such that the cost of the marginal unit of safety equals the valuation a worker would have if he had the correct information about the amount of safety. If one firm cuts the amount of safety, then the cost saving from doing that would be just offset by the increased compensation the firm would have to pay the worker if the worker had perfect information. However, the worker underestimates the cut in safety. The firm will not have to pay the worker as much compensation for the decrease in safety and will gain by decreasing safety. Therefore it will do so. Other firms will follow. The new equilibrium will be one at which the worker's subjective valuation (which differs from the correct valuation) of the marginal unit of safety just equals the cost of producing it.

On the other hand, if workers overestimate differences in safety across firms, then the equilibrium amount of safety will be more than optimal. Implicit in the above argument is the assumption that workers bear some of the liability for injuries to themselves.

To this argument there are a number of answers. First, the problem of bad information about job hazards is not likely to be a big problem in underground coal mining. Coal miners have much information about job hazards in coal mining relative to hazards in other occupations that they see around them. Most of them are the sons of coal miners, and even the grandsons of coal miners. Most of them have heard about coal mine hazards almost from the time they were born. They have heard about injuries from their parents and they have seen around them victims of black lung disease. In fact, on this last point, miners knew about black lung disease long before the medical profession labelled it pneumoconiosis.[9] They have much of their knowledge because of the geographical nature of coal mining. Since coal mining is concentrated in certain areas, there are large markets for newspapers, radio and television that inform people in these areas of the hazards of coal mining. For this reason coal miners are likely to be aware even of relatively fine differences in safety across mines.[10] Therefore the problems due to less than perfect knowledge of safety are likely to be second order.

Second, we would expect, ex ante, that miners would be just as likely to overestimate as to underestimate differences in safety across mines. Therefore, too much safety is just as likely to result as too little safety. It is difficult to see how the argument from worker ignorance would justify government intervention only in the form of minimum safety requirements.

Third, the argument from imperfect information is a necessary but insufficient condition for government intervention.[11] Presumably the

workers do not have perfect information because there is some cost of acquiring the information. The government is not exempt from this problem. The government also has a cost of acquiring information. To acquire information on fine differences in safety across mines, the government would have to have a large staff of bureaucrats gathering this information. In fact, for a time, the government gathered this information. It did so before 1969 when the Coal Mine Health and Safety Act was passed. However, the government officials do not reveal all their information on safety in each mine even though there is no law preventing them from doing so.[12] This information is not very useful if only the government has access to it. That is, the problem of imperfect information about mining hazards is compounded by imperfect information about government actions and reliability. Those who argue for government intervention on the grounds of imperfect worker information must show how they plan to motivate the government to gather the correct kinds of information and to reveal the information it has gathered.

Finally, there is an even more fundamental objection to this argument for government intervention. This argument "reveals the tyranny of the status quo and the poverty of our imagination in fields in which we are laymen, and even in those in which we have some competence, by comparison with the fertility of the market."[13] Let me illustrate by considering a possible market solution for the problem of imperfect information. The solution does not require that workers not be ignorant. All it requires is that workers not be stupid. If they are ignorant of job hazards, they will know that they are ignorant.

Therefore, instead of bearing the liability, as the above argument assumes they do, they could contract with the employer for the employer to bear the liability. They could write a contract with the employer (who, by assumption, does know the job hazards) according to which the employer pays a particular amount for each of a list of injuries to the employee. The amount they would agree on would be just enough to make up for the worker's utility loss in the event of an accident. The employer, since he does have perfect (or close to perfect) information about job hazards, would then take account of all the costs involved in an accident. The optimal amount of safety would result.[14]

If this kind of contract is a good solution to the problem of imperfect worker information, then why did we never see it? There are two possible reasons. One is that the problem of worker misinformation might not be as serious as some would have us believe. Another possible reason is that workers might have been able to avoid accidents (produce safety) at a significantly lower cost than if employers invested in avoiding accidents. In this case the moral hazard problem would have been serious, possibly serious enough to outweigh the gains from having the employer bear the liability.

It might be thought that a third reason for the non-existence of the kind of contract I am suggesting is that such a contract would be found illegal by the courts. However, this is not likely. The courts held contracts exempting an employer from all liability for negligence toward his employees void as against public policy.[15] The rationale given was that the employee was in general at a disadvantage in bargaining power and was at the mercy of the employer. Therefore, the

employee had to be protected by law from the employer's negligence. However specious this reasoning, the cogency of the courts' argument is not at issue here. The issue is the way the courts thought. Once we understand that, we are able to predict whether the courts would have enforced a contract containing a schedule of payments to be made in the event of particular types of accidents.

Before the advent of compulsory workmen's compensation laws in the early 1920's an employer had three common law defenses, the so-called "unholy trinity," against an employee lawsuit for damages sustained on the job. The three defenses were labelled the fellow servant doctrine, the assumption of risk, and contributory negligence.[16] Under the fellow servant doctrine, if an employer could prove that an employee's injury was due to the actions of a fellow employee, then the employer was not liable. Under the assumption of risk defense, if an employee accepted employment then he accepted all the ordinary risk incident to his work, and therefore the employer was not liable for "ordinary" accidents. Under the contributory negligence defense, if an employee was injured through the carelessness of an employer but had contributed to his injury by his own carelessness, then the employer was not liable.

The kind of contract I am suggesting with a schedule of payments to the employee by the employer in the event of an accident would probably have been enforced by the courts if the payments were set above the amount which the employee could expect to collect in the absence of such a contract. The court (not taking into account the compensating decrease in the pecuniary wage) would have interpreted such a contract as benefitting the employee. The courts have also

enforced a contract by which the employer gave up any of his three common law defenses, since they would have interpreted such a contract as benefitting the employee. The only situation under which the courts would have refused to enforce the suggested contract is if the schedule of payments had been below the amounts that the courts would have granted in the absence of such a contract. This last situation seems unlikely since the court awards were very small.[17] Therefore it appears that the contract suggested above would have been enforced by the courts.

The Case of Economies of Scale in Safety Production

Another argument for government intervention is that if there are economies of scale in safety production, then the optimal amount of safety might not be produced. The argument is difficult to state verbally, but can be shown diagramatically.

Assume that there are two types of workers, Type L and Type H, in a geographical area and that there are N/2 of each type. That is, there are N workers in all. Type L workers have a low demand for safety and Type H workers have a high demand for safety. Assume that mine operators cannot distinguish between Type L and Type H workers. Therefore they will have to charge the same price for safety to each. Assume that the lowest cost way of producing a particular type of safety, for example, absence of black lung disease, is to ventilate the mine. Assume further that there are economies of scale in ventilating.

The term "economy of scale" is used here in a special sense. In the context of ventilation, the term would normally be used to apply to a situation in which twice the ventilation, in units of cubic feet per minute, could be produced at less than twice the cost. This is not

the sense in which the term is used here. Rather, the term is used here to characterize a situation in which the cost of providing a given amount of ventilation for each of 2n men is less than twice the cost of providing the same amount of ventilation for each of n men. In the discussion below, I shall take an extreme case in which the cost of ventilation does not vary with the number of men.

Figure II-1 helps clarify the sense in which the term "economy of scale" is used. In Figure II-1, n is the number of men, TC_V is the total cost of ventilation, and v is the amount of ventilation which each man receives. The total cost of ventilation divided by the number of men, TC_V/n, for a fixed v, $\bar{v}$, is plotted on the vertical axis against n on the horizontal axis. As the number of men increases with the amount of ventilation per man held constant, TC_V/n, each man's prorated share of the total cost of ventilation, falls. Note that in this case, with the total cost of providing a given amount of ventilation per man independent of the number of men, TC_V/n is a rectangular hyperbola. The graph of the total cost of providing ventilation, TC_V, for a fixed v, $\bar{v}$, on the vertical axis, plotted against the number of men on the horizontal axis, although not shown here, would be a horizontal line.

In short, the term "economy of scale" is used here to characterize a good for which one man's consumption does not diminish the amount available to another man, that is, a public good.

Is it reasonable to assume that ventilation is a public good? The answer is that it is probably reasonable to assume that it is a public good over a range of workers. For example, the cost of providing a given amount of ventilation may be the same for ten workers as for nine

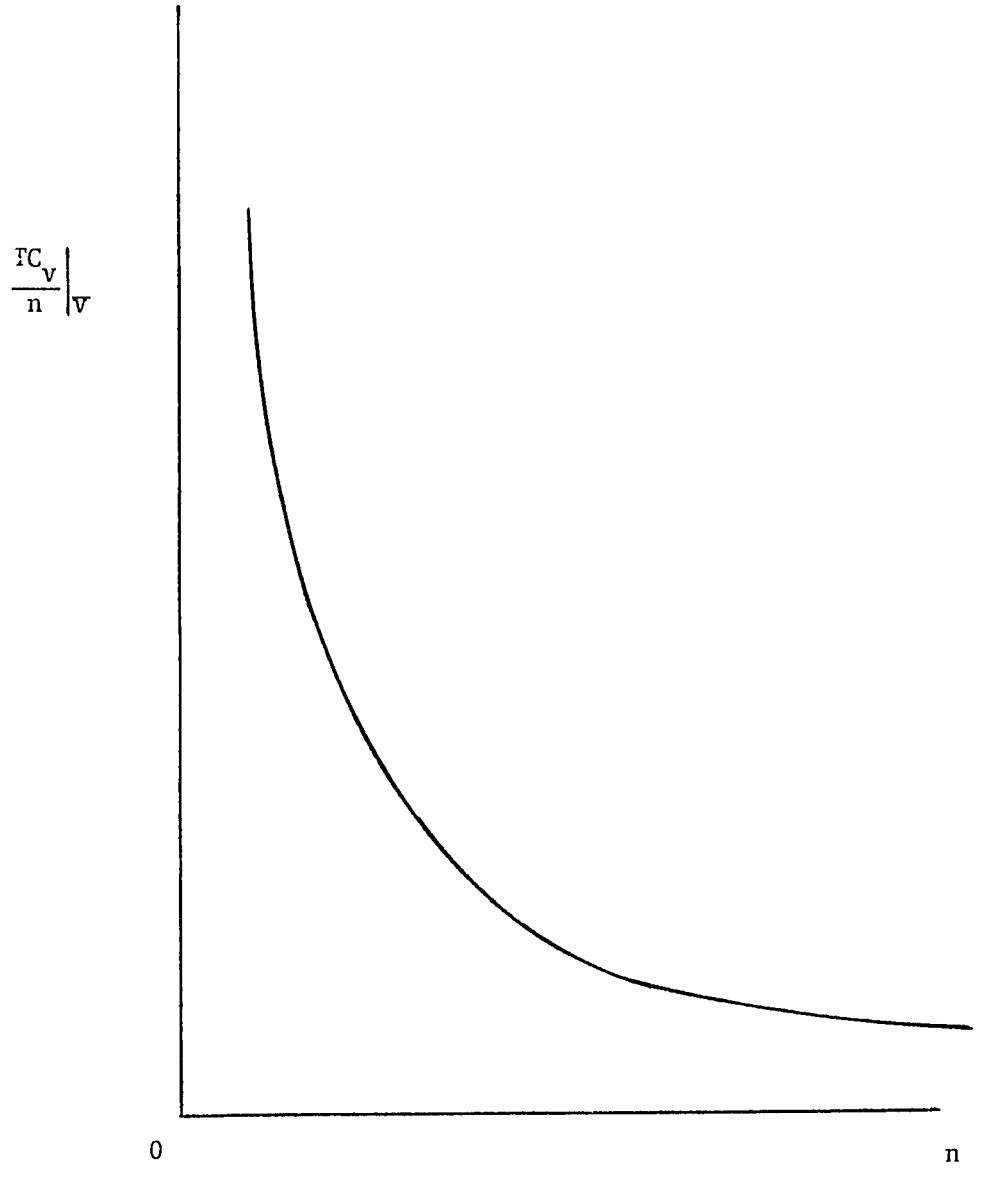

FIGURE II-1: Total cost of ventilation per man for a fixed v.

workers, but the cost for 1000 workers will surely be more than the cost for ten workers.

Since Type L workers have a lower demand for safety than Type H workers, they have a lower derived demand for ventilation. In Figure II-2, D_L is the demand for ventilation of a Type L worker and D_H is the demand for ventilation of a Type H worker. MC/N is the cost per worker of producing ventilation if all workers use the same ventilation equipment. (This requires, of course, that all workers work in the same mine.) $MC/\frac{N}{2}$ is the marginal cost of producing ventilation per worker if each group of workers uses its own ventilation equipment. (This requires that each group work in a different mine or in a different section of the same mine.)

The efficient way of providing a truly public good is obviously to have everyone use it rather than have each group produce its own public good and exclude others from consuming it. In this case, will the two groups use the same equipment? The answer is, "not necessarily."

The proof of this conclusion requires the construction of indifference curves in Q,P space. Leif Johansen[18] has shown that indifference curves can be drawn in Q,P space. In Figure II-2, a Type L worker who buys Q_o units of ventilation at a price of P_o is on the indifference curve I_o.

I_o is horizontal at the point (Q_o,P_o) and falls from this point on both sides of point (Q_o,P_o). Although neither Johansen nor Jaffee and Russell point it out, this makes intuitive sense. To see why, start at point A on I_o and move horizontally to point B. The coordinates of point B are (Q_1,P_o) where Q_1 is less than Q_o. Since the

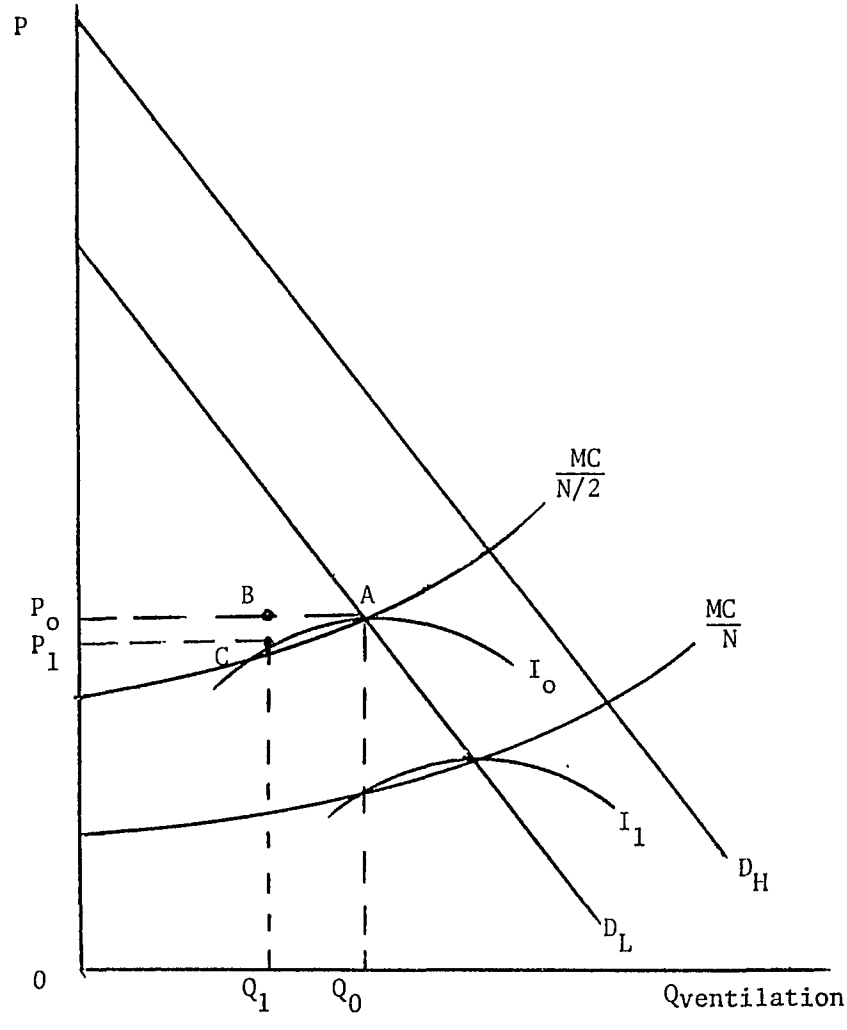

FIGURE II-2: Demand for ventilation and indifference curves for high and low demanders.

worker can demand any amount at price P_o and demands Q_o, we know that he must prefer Q_o to any other quantity at price P_o. Therefore to make him indifferent between point (Q_o,P_o) and a lower quantity Q_1, we would have to offer him a price lower than P_o, say P_1. Thus we see that the indifference curve must slope down from right to left as we move away from (Q_o,P_o). Similar reasoning would show that the indifference curve must slope down from left to right as we move away from (Q_o,P_o). Therefore, I_o must be horizontal at (Q_o,P_o).

As the worker moves down his demand curve, he reaches higher and higher indifference curves. In Figure II-2, I_1 represents a higher level of utility than I_o. Although neither Johansen nor Jaffee and Russell point this out, this result is also intuitive. As the worker moves down his demand curve, his "consumer" surplus increases. Obviously, he must be on a higher indifference curve.

Now turn to Figures II-3 and II-4 for proof of the contention that the optimal amount of safety might or might not result. In Figure II-3, the indifference curves I_o^L and I_o^H are drawn to intersect above the line MC/N which is the marginal cost per person if the two groups of workers get together and consume the same ventilation. There is a cone-shaped area bounded by I_o^L, I_o^H and MC/N in which both groups of workers would be better off than they would be if each group consumed ventilation separately. If an entrepreneur were to offer a quantity of ventilation between Q_A and Q_B at a price equal to his marginal cost per worker,[19] he would be able to attract workers from mines producing quantities Q_L and Q_H respectively. Therefore, in this case the two groups of workers would use the same ventilation equipment. Would they consume

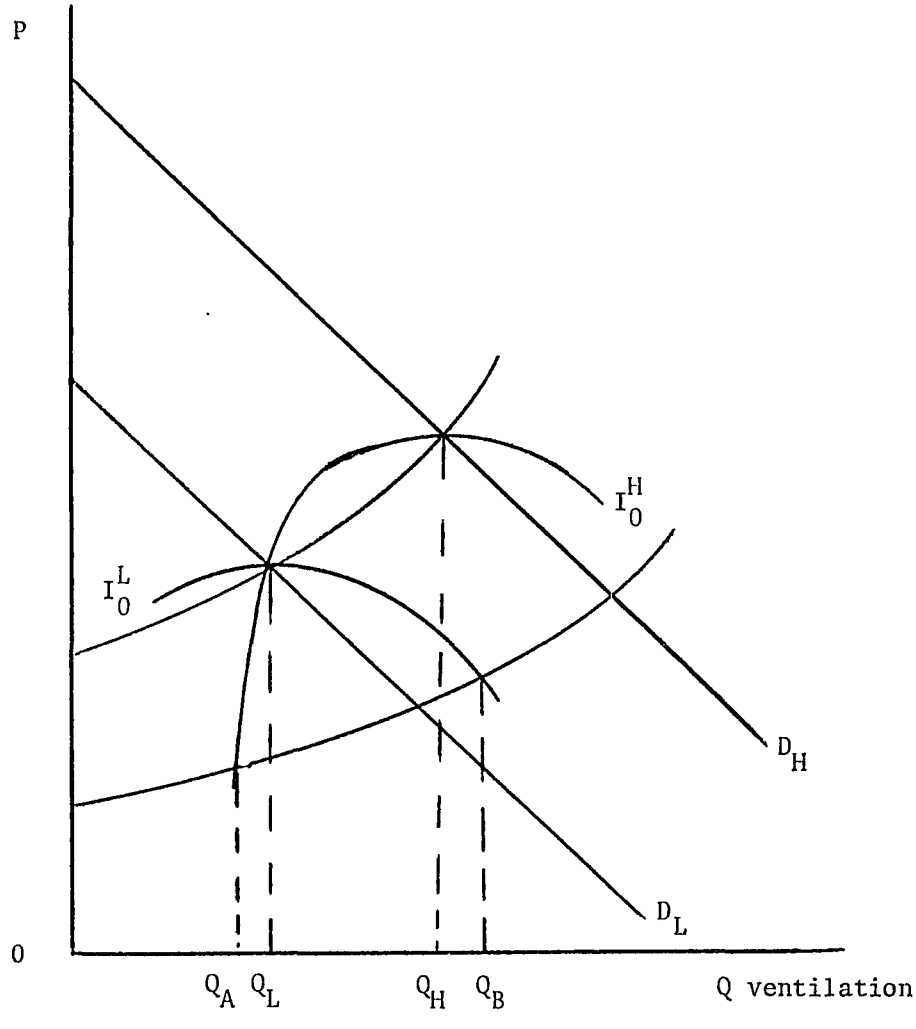

FIGURE II-3: Case in which high and low demanders share ventilation equipment.

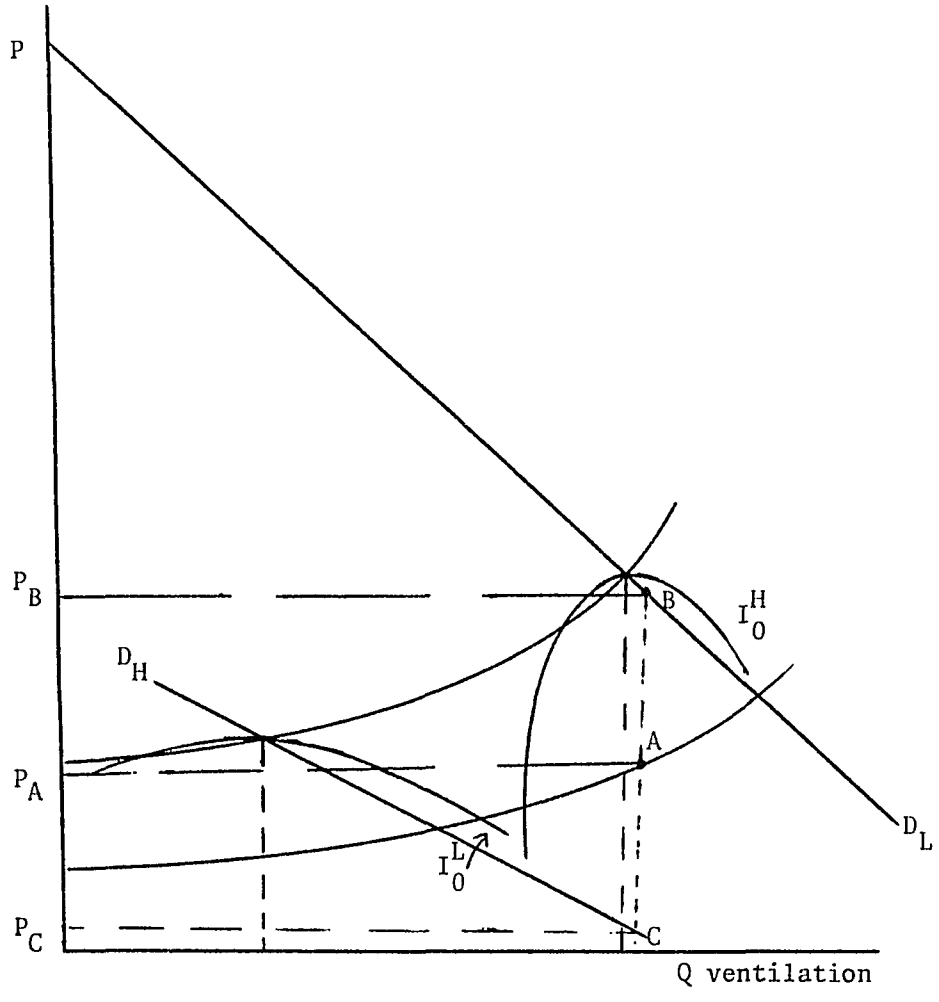

FIGURE II-4: Case where high and low demanders separate.

the efficient amount of ventilation? It depends on tastes. The efficient (in the Samuelson[20] sense) amount of ventilation is the amount such that the marginal cost of ventilation equals the sum of the marginal rates of substitution between ventilation and the numeraire. In Figure II-3, the efficient amount of ventilation is given by the intersection of the vertical average of D_L and D_H with MC/N.[21] This quantity is not shown on the diagram in the interest of diagrammatic simplicity. Clearly, the indifference curves can be drawn so that the efficient amount of ventilation is produced, although the result would be serendipitous.

Now see Figure II-4 for a case where the two groups of workers will not get together and consume the same ventilation. In this case, the indifference curves I_o^L and I_o^H do not intersect above MC/N and therefore there is no feasible area which the two groups of workers could move to where they both be better off than when they consume different amounts of ventilation. Type L workers will consume Q_L of ventilation and Type H workers will consume Q_H of ventilation.

It might be thought that the high demanders of ventilation might consume more than the efficient amount of ventilation. However, this is not so. Both groups will consume less than the optimal amount of ventilation. The proof is a simple algebraic one. The high demanders will demand an amount of ventilation such that the demand price, D_H, equals $MC/\frac{N}{2}$, which equals 2MC/N. Therefore the equilibrium condition for high demanders is $D_H/2 = MC/N$. Clearly, if D_L is positive at the high demanders' equilibrium amount of ventilation, then efficiency dictates that ventilation be increased above the equilibrium amount

demanded by higher demanders. QED.

Note that this result does not depend on the fact that the two groups contain an equal number of workers. In the more general case where there are m workers in group L and N-m workers in group H, the result still holds. The equilibrium amount of ventilation for high demanders is given by the equation, $D_H = \frac{MC}{\frac{N-m}{N} \cdot N}$, which can be rearranged to give $\frac{N-m}{N} D_H = \frac{MC}{N}$. The efficient amount of ventilation is such that the sum of the demand prices, $m \cdot D_L + (N-m) \cdot D_H$, equals MC, the marginal cost. Dividing both sides by N gives $\frac{m D_L}{N} + \frac{(N-m) D_H}{N} = \frac{MC}{N}$ as the condition for efficiency. Therefore, as long as D_L is positive at the high demanders' equilibrium, then the efficient amount of ventilation exceeds the higher demanders' equilibrium amount.

All of the analysis in this section was based on the implicit assumption that the mine operator could not distinguish between low and high demanders. If the operator could distinguish between them there would be no problem. To see this, consider Figure II-4, where A is the efficient amount of safety. Rather than charge all workers P_A for ventilation, the mine operator could charge Type H workers P_B and the Type L workers P_C, where $P_A = \frac{P_B + P_C}{2}$. Since point B lies on a higher Type H indifference curve than I_o^H and since point C lies on a higher Type L indifference curve than I_o^L, both groups of workers will accept the mine operator's offer.

To what extent is the "economies of scale" problem likely to be significant? If employers can costlessly distinguish between workers, it will not be a problem. However, there is an incentive for each worker to claim that he is a Type L worker since the price he will have to pay as a Type L worker will be lower. Therefore, it might be difficult for employers to distinguish between types of employees.

Clearly, the more similar are workers' tastes, the higher is the probability that workers will use the same safety equipment. Therefore, the more similar are workers' tastes, the less likely is this to be a problem. Also, the lower the extent of economies of scale, that is, the higher the congestion costs as more workers use the same safety equipment, then the lower the likelihood that this will be a problem.

What then are the implications for government intervention? Strictly speaking, none. For the government to intervene optimally, it would have to obtain information on workers' tastes and then on that basis decide whether the existing amount of safety was optimal. But as we have just seen, the whole problem arose only if employers did not have information on individual workers' tastes. The same conditions which would prevent the private market from generating the efficient (in the Nirvana sense)[22] amount of safety would prevent the government from generating the "efficient" amount of safety, since the government would not have the requisite information either.

Imperfect Competition in the Labor Market

The result of optimal safety derived earlier in this chapter depended on the assumption that the labor market was perfectly competitive. However, a large percent of the labor force is represented by a

monopoly union, the United Mine Workers of America. What happens when we introduce a monopolized labor force into the analysis?

In order to derive most results in labor economics when labor is represented by a monopoly union, one must know the union's objective function. For instance, in order to know what will be the equilibrium wage and employment in a unionized industry, one must know whether the union is maximizing the wage bill (in which case it would go to the point on the labor demand curve at which the elasticity of demand for labor is unity), the wage per worker (in which case, the membership of each union would be unity), or some other function. In this case, however, knowledge of the union's objective function, if one can even talk of "the" objective function of a large organization of individuals, is less important. Knowledge of the union's objective function would be important if one were interested in knowing how much safety the union would bargain for. But this is not the issue that concerns us here. Rather, we are interested in the answer to the question, "Whatever the level of the pecuniary and non-pecuniary wage package the union bargains for, is the composition of the package optimal?" To this question one can not give a definite answer but one can answer that at least there are no obvious forces which would cause a distortion of the wage package and there are forces, namely, the force of mutual gains from trade, which would lead to no distortion.

For instance, if the union is a worker-dominated union, then it will want to maximize "profits" where profits are defined as the difference between the wage bill and aggregate worker supply price. Doing so will lead it to bargain for safety up to the point where the

value of the marginal unit of safety (which is equal to the aggregate decrease in workers' supply prices) equals the marginal cost of safety (which is equal to the decrease in the amount firms are willing to pay to hire workers).

If the union is completely leader-dominated, that is, if the heads of the union collect all the monopoly rent and the workers receive a competitive wage, then the optimal amount of safety will again result. This time, the amount of safety will be less than the amount in the case of worker control. The reason is that the total wage package that the worker receives will be lower and with this lower wage package he will "buy" less safety, since he will be less wealthy. If the union is leader-dominated, the union leaders will have no special incentive to skimp on safety. If the union bargains for too little safety, there will be unexploited gains from trade. The workers can offer to "buy" more safety (by lowering their supply prices) and the union bosses who are maximizing profits will oblige. As long as the rights to the monopoly profits are well-defined, then the optimal amount of safety will be produced no matter who owns these rights (although this optimum will be different in the above two cases if safety is a normal good). In fact the UMW has elements of worker domination and boss domination.[23]

There is one problem that potentially exists with a monopoly union that would not exist in a competitive labor market. If the monopoly union bargains for a uniform wage as the UMW does, there might be a problem of maldistribution of safety across workers. Even though

the "aggregate" amount of safety may be correct, some of the workers will have too much safety and too low a pecuniary wage, while other workers have too little safety and too high a pecuniary wage.

This problem exists only if workers cannot buy safety directly. That is, if the production function for safety were such that each worker could efficiently buy his own, then each worker could take his monopoly wage and buy the amount of safety he wanted. This is possible for some of the components of the safety package, for example, hard hats, pants, and boots, but not for others, for example, ventilation or policing of other workers.[25] It might be thought that each worker could buy his own optimal amount of safety from the employer by taking a lower wage. But then who would stop the employer and employee from cheating on the uniform wage? In order to maintain the monopoly power of the UMW, the leaders must prevent local bargaining over terms of the labor contract.

What are the implications of this problem of maldistribution of safety across workers for government intervention? The solution would be to get rid of the government intervention which created the problem in the first place. The UMW holds its monopoly for two reasons. One reason is that the Wagner Act of 1935 forces all the employees in a certain class of labor in a firm to join a union if the majority votes to join. The other, and probably more important reason, is that unions have the de facto power to prevent employers from hiring other workers to take their place when they go on strike. Without this power, the strike would be nothing more than a mass resignation.[26] Therefore if this power were removed, the source of the non-optimal distribution of

safety across workers would vanish.

An Aside on Labor Immobility

A reason often raised by economists for why safety might be less than optimal is that labor is immobile.[27] The argument has never been clearly specified. Apparently, if workers are "stuck"[28] in their present job, they cannot choose more or less safety. This argument leaves out the possibility of a bargain between the worker and the employer. If the worker values another unit of safety more than it costs, he would be willing to "buy" this extra safety with a lower pecuniary wage offer. The fact that the worker is "stuck" in his present job does not preclude this kind of bargain. If safety is a normal good, he might demand less safety than he would if his cost of moving were zero, since his wealth will be lower. However, the amount of safety he demands and receives will still be optimal given his wealth.

Conclusion

In light of the above arguments, the case for government intervention in the safety decision of firms and employees is not persuasive. The argument for government dictation of the production function for safety is even weaker, since the efficient way of producing safety is likely to vary over mines and over time.

In the next two chapters, I shall discuss some of the effects of specific safety legislation.

FOOTNOTES

1. See, for example, Robert S. Smith, The Occupational Safety and Health Act (Washington, D.C.: American Enterprise Institute, 1976), p. 31.

2. Later these assumptions will be dropped one by one and the consequences examined.

3. This is how I interpret Peter A. Diamond and James A. Mirrlees, "On the Assignment of Liability: The Uniform Case," Bell Journal of Economics 6 (Autumn 1975): 487-516.

4. This assumes, of course, that he is not risk averse enough to pay a premium for liability insurance which covers the transactions costs of insurance.

5. See Guido Calabresi, The Costs of Accidents (New Haven: Yale University Press, 1970).

6. See the quote from Smith at the start of this chapter.

7. This result has been mathematized by Walter Y. Oi, "An Essay on Workmen's Compensation and Industrial Safety" (unpublished, University of Rochester, 1973): 28.

8. See H. Gregg Lewis, Unionism and Relative Wages in the United States (Chicago: University of Chicago Press, 1963), pp. 73-80, and Rush V. Greenslade, "The Economic Effects of Collective Bargaining in Bituminous Coal Mining" (unpublished Ph.D dissertation, University of Chicago, 1952).

9. See Joseph E. Finley, The Corrupt Kingdom (New York: Simon and Schuster, 1972), pp. 222-223.

10. When I worked in a nickel mine in a mining community I worked for a firm which had a reputation for being safer than another mining firm in the same town. Even I learned this after being in the community for two weeks. As one would expect, the wages in the firm I worked for were lower than at the other firm.

11. See Harold Demsetz, "Information and Efficiency: Another Viewpoint," Journal of Law and Economics 12 (April 1969): 1-22.

12. I have had a very difficult time getting information from the Mining Enforcement and Safety Administration (MESA) which enforces federal regulations in underground coal mines.

13. Milton Friedman, Capitalism and Freedom (Chicago: University of Chicago Press, 1962), p. 158.

14. Note that in this case, since the worker no longer bears liability for injury, the pecuniary wage no longer reflects the hazardous nature of the job.

15. For the case law on this issue see Tarbell v. Rutland Co., 1901, 73 Vt. 347, 51 A. 6; Johnston v. Fargo, 1906, 184 N.Y. 379, 77 N.E. 388. These cases are referenced in William L. Prosser, Handbook of the Law of Torts, 3d ed., (St. Paul, Minnesota: West Publishing Co., 1964), p. 545. I am grateful to Sam Kazman for his help on this point.

16. See Walter F. Dodd, Administration of Workmen's Compensation (New York: The Commonwealth Fund, 1936), pp. 4-8.

17. In 91 percent of 604 fatal cases in New York, Pennsylvania and Minnesota before 1911, less than $1,000 in damages was awarded to the deceased workers' survivors. See Herman M. Somers and Anne R. Somers, Workmen's Compensation (New York: John Wiley and Sons, Inc., 1954), p. 24.

18. See Leif Johansen, "Some Notes on the Lindahl Theory of Determination of Public Expenditures," International Economic Review 4 (September, 1963): 346-348. Dwight Jaffee and Thomas Russell derived independently the construction of indifference curves in Q,P space in, "Imperfect Information, Uncertainty and Credit Rationing" (unpublished paper, Princeton University, 1975).

19. If workers are liable for injuries, they "pay" for ventilation by taking a wage cut. If employers are liable then they get "paid" for ventilation by facing a lower probability of having to compensate workers for black lung disease.

20. Paul A. Samuelson, "The Pure Theory of Public Expenditure," Review of Economics and Statistics 27 (November, 1954): 387-389.

21. This is because MC/N represents the average marginal cost of producing ventilation (averaged over the number of workers). Therefore the relevant magnitude to equate to it is the average marginal valuation. To assure himself that this is true, the reader should multiply both D_L and D_H by N/2 and add the multiples, and then multiply MC/N by N. The results would be the total worker demand and the marginal cost, respectively. Equating these yields the efficient output of the public good. But this equation,

$$D_L \cdot \frac{N}{2} + D_H \cdot \frac{N}{2} = MC,$$

is unchanged by a division of both sides by N. Dividing by N, we get $D_L/2 + D_H/2 = MC$, or, $\frac{D_L + D_H}{2} = MC$. QED.

22. See Demsetz, "Information and Efficiency."

23. See Brit Hume, Death in the Mines (New York: Grossman Publishers, 1971) and Finley, Corrupt Kingdom.

24. A possible reason for the industry-wide wage bargain is that the wage which would be bargained to by any one local would be below the wage which would be bargained to by the industry-wide union. The reason is that no local would take into account the positive externality it could create by raising the wage more. If it raised the wage more, less labor would be hired and less output would be produced by this local. Therefore the demand for coal produced by other locals and consequently the derived demand for the labor of other locals would be higher and members of other locals would be better off. Possibly the function of a national union is to internalize this pecuniary externality by making an industry-wide bargain.

25. Much of the safety problem is an externality problem. If individual A smokes or is careless, some of the costs are borne by other individuals.

26. See Armen A. Alchian and William R. Allen, University Economics, 3d ed. (Belmont, California: Wadsworth Publishing Company, 1972), p. 431.

27. See Robert Smith, Occupational Safety and Health Act, p. 25.

28. What does it mean to say a worker is "stuck" in his present job? Does it mean he is earning rents?

CHAPTER III

THE EFFECTS OF THE 1952 LEGISLATION

> ...it is easy to exaggerate the ambiguity of historical experience: after all, the past is the only source of knowledge of the future. Our trouble, frankly, is less that history speaks obscurely than that we have listened carelessly. We have not studied the experience of economic reform, and know not its successes nor its failures, its lessons on ways to proceed and ways to avoid.
>
> --George J. Stigler, "The Tactics of Economic Reform" in The Citizen and the State (Chicago: University of Chicago Press, 1975), p. 27.

Background

Before the federal act of July 15, 1952, there was no significant federal regulation of underground coal mines. By the law of May 7, 1941, federal inspectors were empowered to enter an underground coal mine and make safety inspections but their recommendations for improvement did not have the force of law. Also, from June 1, 1946 to March 25, 1947,[1] during the period that the federal government was running all the unionized coal mines after forcibly taking them over, the government enforced the Federal Mine Safety Code.[2]

Then on December 21, 1951, in a mine in West Frankfort, Illinois, an explosion of methane which in turn ignited coal dust killed 119 men. Congress responded by holding hearings on a bill to regulate safety in coal mines. On July 16, 1952, the bill became Public Law 552. The stated congressional intent of this law was to prevent "disasters."[3] A disaster was defined by the Bureau of Mines as an accident in which five or more men were killed.[4]

Figures III-1 and III-2 give an idea of the magnitude of the type of accidents that the law was aimed at preventing. In Figure III-1, line EEF is a plot of fatalities due to explosions of gas or coal dust and due to accidents involving electricity. These two categories of accidents are roughly the categories that the law was aimed at. The line OTHERF is a plot of all fatalities not in the above two categories. Similarly, in Figure III-2, EENF is a plot of non-fatal injuries in the above two categories, and OTHERNF is a plot of non-fatal injuries not in these categories. (The data are for all underground bituminous coal mines.) Clearly, the act was aimed at only a small fraction of the accidents in underground mines.

The Terms of the 1952 Act[5]

The 1952 Act applied only to underground coal mines which had more than 14 people regularly employed underground.[6] That is, small mines were exempt from regulations. Under Section 202, all mines which were regulated by the Act were to be inspected at least once each year by an inspector authorized by the U.S. Bureau of Mines.

Under Section 209, there were a number of specific technological requirements for producing safety. The roofs and ribs of all active underground roadways and travelways had to be "adequately" supported. All active underground work places had to be ventilated by a current of air of at least 6000 cubic feet per minute in bituminous mines and of at least 200 cubic feet per minute in anthracite mines. Coal dust, loose coal and other combustible materials were not permitted to accumulate in active underground workings. Where mining operations raised an excessive amount of dust into the air, water had to be added to wet

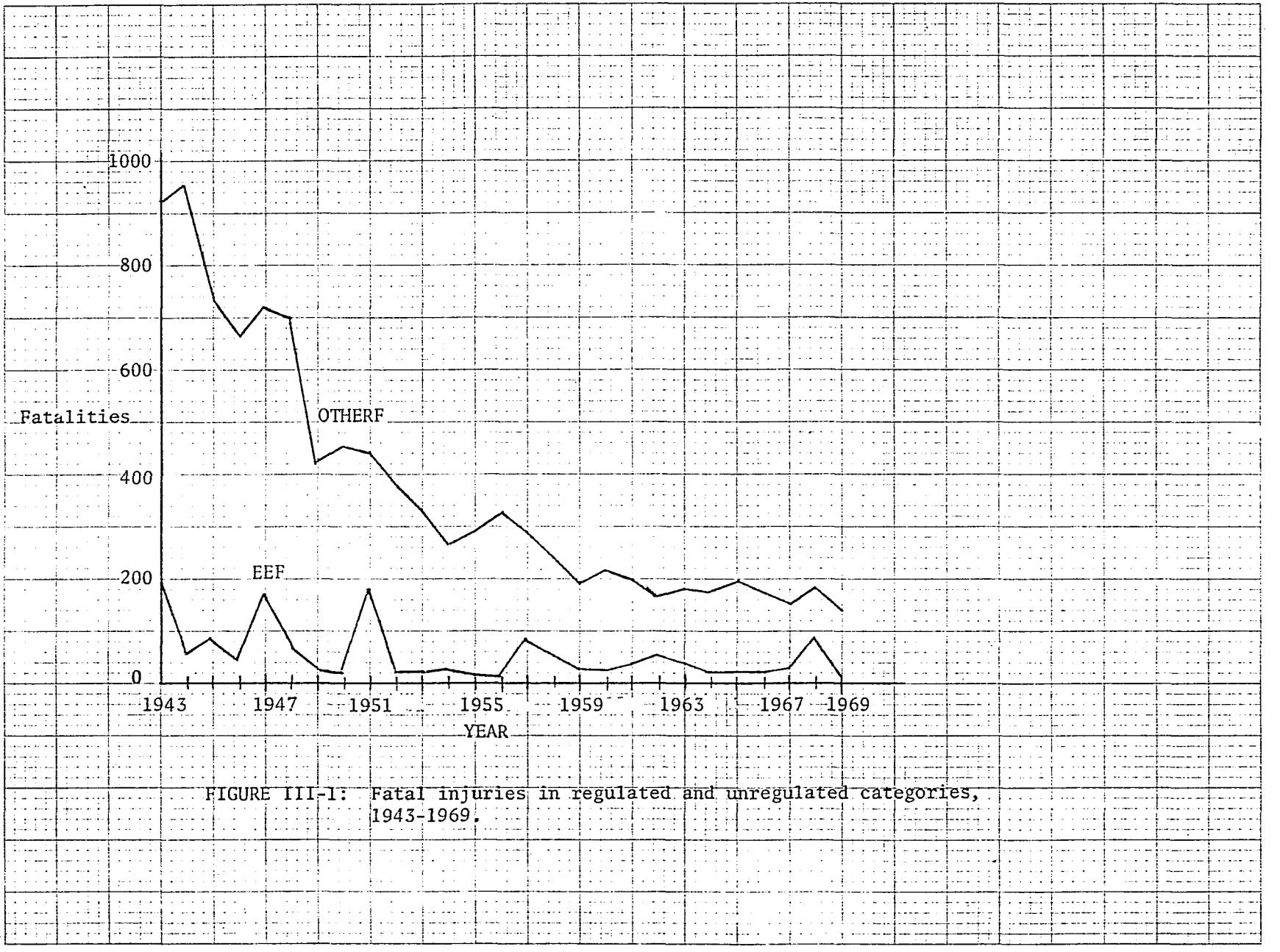

FIGURE III-1: Fatal injuries in regulated and unregulated categories, 1943-1969.

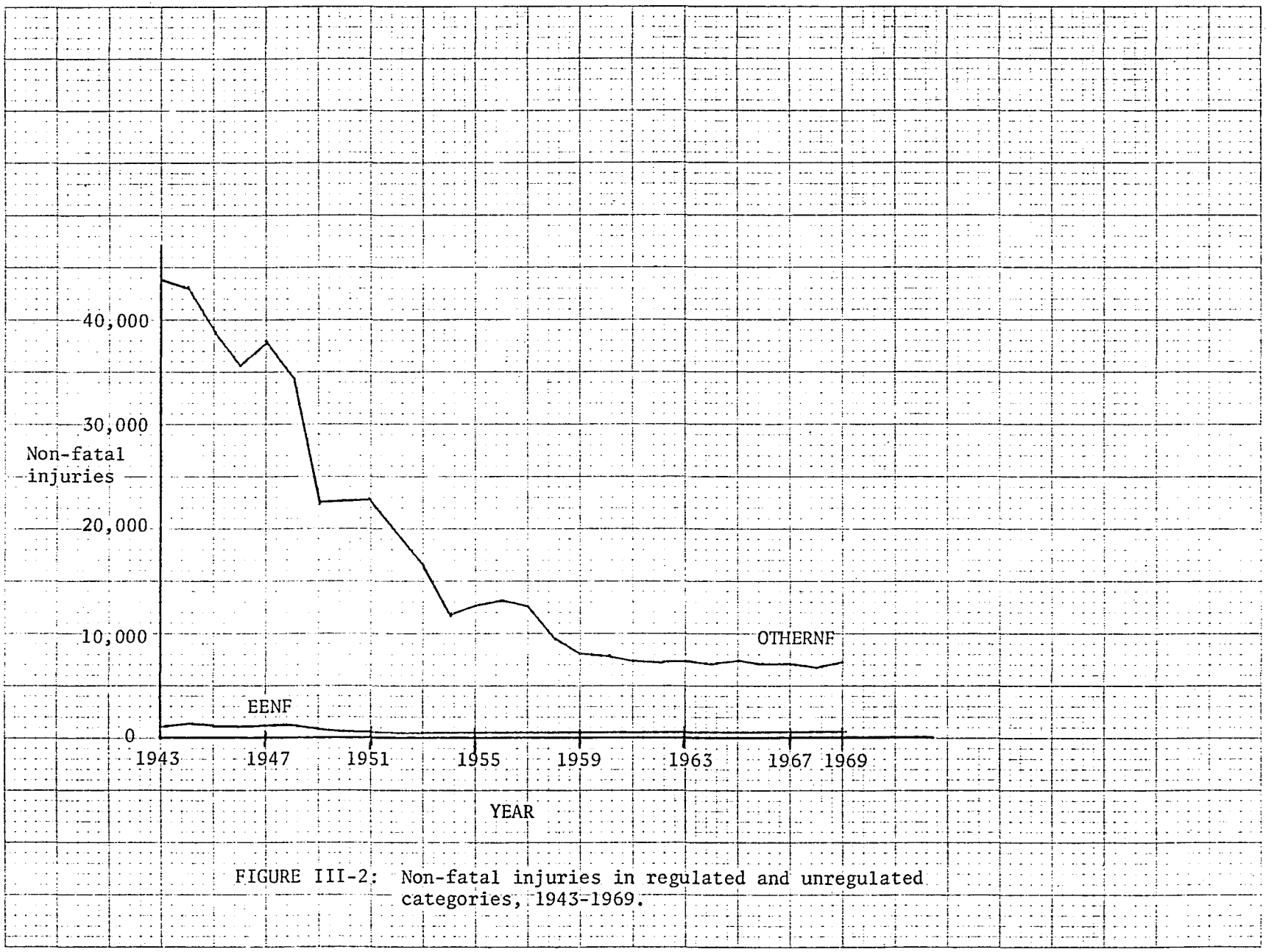

FIGURE III-2: Non-fatal injuries in regulated and unregulated categories, 1943-1969.

it down. All mines except mines in which the dust was too wet or too high in incombustible content to propagate an explosion had to be rock-dusted to prevent explosions. All mines had to have "suitable" fire-fighting equipment. Underground structures installed after the date of the Act were to be of fire-proof construction.

In so-called gassy mines, that is, mines in which methane constituted more than .25 percent of the air, an examination had to be made before every shift for accumulations of methane. (Methane, if ignited, would explode). In non-gassy mines, the test for methane had to be made only every production day. Finally, in all gassy mines, electrical equipment was required to be "permissible." Permissible equipment was equipment which the Bureau of Mines certified would not spark and cause an explosion. However, the clause requiring permissible electrical equipment was a "grandfather" clause. If the mine operator was presently using non-permissible equipment or had ordered non-permissible equipment by the time of the Act, then he was allowed to use it until it wore out.

Under Section 203, if an inspector found imminent danger of a mine explosion, mine fire, mine inundation, or man-trip or man-hoist accident, then he was required to issue an order requiring all workers in that section of the mine to withdraw. If the inspector found any part of Section 209 violated without imminent danger of mine explosion, mine fire, mine inundation, or man-trip or man-hoist accident, then he was required to set a "reasonable" amount of time for abatement of the violation, but the coal mine operator was allowed to continue operating the section of the mine in which the violation occurred. At the end of the time which the inspector set for abatement of the violation of

Section 209, the inspector was required to make a special inspection of the mine to see if the violation had been abated. If it had not been abated, then the inspector had the discretion to decide whether to grant an extension of the time period. If he chose not to grant an extension, then he was required to issue a withdrawal order requiring immediate withdrawal of all workers from the section of the mine where the violation was unabated. If on inspection, the inspector found that methane had been ignited or if he found methane in an amount greater than .25 percent, then the operator was required to comply with the provisions of Section 209 which applied to gassy mines.

Section 210 set the penalties for non-compliance. Any operator of a mine who failed to withdraw workers from a section of a mine when so ordered under Section 203, was to be fined up to $2000. Any worker in a mine who remained in or entered a section of the mine when the section was to be clear under Section 203, was to be fined up to $2000. Finally, any coal mine operator who refused to allow an inspector to make an inspection was to be fined up to $500. Although the Act does not specify, presumably each failure to comply with Section 203 was treated as a separate offense.

Sections 206 to 208 set the rules for review of decisions. Under Section 206, a coal mine operator ordered to withdraw workers from an area of his mine under Section 203, could appeal to the Director of the Bureau of Mines. The Director was required to send out a special three-man inspection team not including the original inspector who made the withdrawal order. This team was required to determine if there had been a violation at the time of the original order. If there had been

no violation, then the withdrawal order was to be annulled. If there had been a violation but the violation had been abated, then the withdrawal order was to be annulled. If there had been a violation but the violation had not been abated, then the three-man team was given the same discretionary power as the original inspector about whether to extend the period for abatement or to affirm the original withdrawal order.

Section 207 provided for review of an inspector's orders or the review of the Bureau of Mines Director's decision made under Section 206. The review was to be made by the Federal Coal Mine Safety Board, a three-man board appointed by the President. The board was to be composed, under Section 205, of one person who represented "the viewpoint of coal mine operators," one person who represented "the viewpoint of coal mine workers," and one person who was to be a graduate engineer with experience in the coal mining industry. This review was to be made on application by the coal mine operator. The Board, in making its review, was not allowed to order an inspection of a mine to help it reach its decision.

Finally, Section 208 provided for judicial review of the Federal Coal Mine Safety Board's decision upon application of the Director of the Bureau of Mines or the coal mine operator.

The Effects of the 1952 Act

In this section I shall formulate and test two hypotheses: (1) the hypothesis that mines shifted from the regulated to the unregulated category in response to the 1952 Act, and (2) the hypothesis that fatalities and non-fatal injuries in the regulated category fell relative to

the unregulated category. It should be noted that in testing these hypotheses, there is no necessary reason for the effects of the 1952 Act to show up immediately. It would take some time for the federal government to set up an active bureaucracy to enforce the law. Moreover, grandfather clauses would delay the full impact of the law.

The Mine Shift Hypothesis

To the extent that the 1952 Act was a binding constraint, that is, to the extent that it forced coal mine operators to do things that they would not otherwise have done, then it would have the same effect as a tax. Of course, it could be that the regulation was net on a subsidy. Since the inspectors provided information about dangerous conditions, they might have saved investment in this information by coal mine operators. The information component would be a subsidy if the inspector's information had positive value and if the cost of disruption of work effort for the duration of the inspector's visit were less than this value. However, the requirement that safety be produced in a specific way would unambiguously be a tax. Whether the net effect would be a tax or subsidy is an empirical issue. We do not have to worry about that issue, however, since by the law of May 7, 1941, small mines were inspected also, but the inspector's recommendations did not have the force of law. Thus small mines received the subsidy without the tax, while larger mines both received the subsidy and paid the tax. There would still be a differential impact of the 1952 Act on small and large mines in the predicted direction.

Coal mine operators faced with this regulatory tax would seek to avoid it. They could do this by shifting from the regulated sector to

the unregulated sector. The regulated sector consists of Title II mines and the unregulated sector consists of Title I mines and non-underground (augur and strip) mines.

Therefore, if the constraint was binding, the first prediction one would make is that, ceteris paribus, the number of Title II mines would fall relative to the number of Title I mines. Tables A-1 and A-2 in the Appendix contain data on the number of Title I and II mines by states for the years 1948 to 1961.

The first test of this hypothesis was to compare the mean ratios of Title I mines to all underground mines nationally before and after the legislation. To avoid capturing the period of adjustment to the Act, the ratios for the years from 1953 to 1955 were excluded from the calculation of the post-legislation mean ratio. The ratios from 1948 to 1961 are given in Table A-3. The results are consistent with the mine shift hypothesis. The mean ratio of Title I to all mines before the legislation was .63 and after the legislation was .82. A statistical test[7] was done to see if the means were significantly different. The difference between the means was .19. The difference would have had to be only .06 for one to be 95% confident that the means were different.

Since the legislation was national in scope, the ratio of Title I to all mines should have increased not only nationally but also in each state. Table A-4 gives the ratio over time for each of 12 states.[8] The pre- and post-legislation means[9] are given in Table III-1, along with the difference between the means and the difference required for one to be 95% confident that the means were different. In 10 of 12

TABLE III-1: Mean Ratio of Number of Title I to Total Number of Mines, Differences between Means, and Differences Required for Significance, by States, 1948-1962.

STATE	MEAN RATIO BEFORE LEGISLATION	MEAN RATIO AFTER LEGISLATION	DIFFERENCE IN MEANS	DIFFERENCE REQUIRED FOR SIGNIFICANCE
Alabama	.75	.85	.10*	.09
Colorado	.77	.84	.07*	.04
Illinois	.38	.41	.03	.12
Indiana	.49	.66	.17*	.08
Kentucky	.77	.89	.12*	.11
Ohio	.80	.85	.05*	.05
Penn. (Bit.)	.58	.86	.28*	.05
Tennessee	.75	.93	.18*	.11
Utah	.63	.61	-.02	.06
Virginia	.60	.92	.32*	.12
West Virginia	.40	.73	.33*	.09
Penn. (Anthr.)	.37	.93	.56*	.05

*Indicates significance at 95% confidence level,

states, the ratio was significantly higher after the legislation. In Illinois, the ratio was higher after the legislation, but insignificantly so. The results are in general consistent with the mine shift hypothesis.

Ideally, one would like even finer data on the size distribution of mines in order to test the mine shift hypothesis. The reason is that if the Act caused the shift then the shift should have been predominantly from mines with slightly more than 14 workers to mines with slightly fewer than 15 workers. This is because the cost of changing the size of the mine's labor force would have been positively correlated with the size of the change. A mine with 17 workers, for instance, would have had a lower cost of adjusting to a labor force of 14 than would a mine with 30 workers. Mine operators would not have had an incentive to shift to a labor force of size much lower than 14. The reason is that there must have been some non-regulatory cost of having a labor force of size less than 15 which motivated coal mine operators to have a larger labor force in the first place. This cost was worth bearing to some coal mine operators when regulation was introduced. They could avoid some of this cost by reducing their labor force to size 14 rather than, say, to size 5.

One would expect, therefore, a larger relative increase in the number of mines which employed 10 to 14 men than in the number of mines which employed one to four men. One would also expect a larger decrease in the number of mines with 15 to 19 men than in the number of mines with over 50 men.

This suggests that it would be desirable to disaggregate the data

on numbers of mines into narrower size categories. The data exist at the national level to do this. During the relevant period, the Bureau of Mines reported the number of mines and output of mines by labor force size categories. The data were broken down into mines of labor force size of one to four, five to nine, 10 to 14, 15 to 19, 20 to 24, 25 to 49, and 50 and over, men.

Table A-5 gives the ratio of the number of mines in each labor force size category to the total number of mines in bituminous underground mining. The means of the ratios and the differences between the means are reported in Table III-2. The results do not support the hypothesis about the relative shift of mines. Although there was a significant increase in the fraction of mines in the one to four man category and a significant decrease in the fraction of mines in the 15 to 19, 20 to 24, 25 to 49, and 50 men and over category, the decrease in the fraction of mines in the 50 men and over category was larger percentage-wise than the decrease in the fraction in the 15 to 19 men category, the opposite of what was predicted. Moreover, there was a small decrease in the fraction of mines in the 10 to 14 men category.

The same test was tried for Pennsylvania anthracite mines. Table A-6 gives the number of mines in each labor force size category as a fraction of the total number of mines in anthracite underground mining. The means of the fractions and the differences between them are reported in Table III-3. The fraction of mines in the one to four man category was increased by 14 times. The fraction in all the other categories decreased. This result is initially discouraging for the hypothesis being tested here. It is somewhat puzzling why the 1952 Act would

TABLE III-2: Mean Ratio of Number of Mines in Various Labor Force Size Categories to Total Number of Mines before and after Legislation, Differences between Means, and Differences Required for Significance, Bituminous.

LABOR FORCE SIZE (MEN)	MEAN RATIO BEFORE LEGISLATION	MEAN RATIO AFTER LEGISLATION	DIFFERENCE IN MEANS	DIFFERENCE REQUIRED FOR SIGNIFICANCE
1-4	.24	.43	.19*	.06
5-9	.26	.29	.03	.06
10-14	.13	.11	-.02	.04
15-19	.069	.041	-.028*	.021
20-24	.040	.021	-.019*	.015
25-49	.087	.041	-.046*	.018
50+	.184	.071	-.113*	.026

*Indicates significance at 95% confidence level.

TABLE III-3: Mean Ratio of Number of Mines in Various Labor Force Size Categories to the Total Number of Mines before and after Legislation, Differences between Means, and Differences Required for Significance, Anthracite.

LABOR FORCE SIZE (MEN)	MEAN RATIO BEFORE LEGISLATION	MEAN RATIO AFTER LEGISLATION	DIFFERENCE IN MEANS	DIFFERENCE REQUIRED FOR SIGNIFICANCE
1-4	.049	.742	.693*	.025
5-9	.186	.141	-.045*	.029
10-14	.138	.043	-.095*	.041
15-19	.060	.017	-.043*	.020
20-24	.051	.010	-.041*	.007
25-49	.157	.017	-.140*	.034
50+	.398	.032	-.366*	.022

*Indicates significance at 95% confidence level.

cause a shift from these latter categories to the one to four man category. We need not look far for an answer however. In 1953 the Pennsylvania legislature passed an Act regulating safety in anthracite coal mines which exempted mines with fewer than four workers employed underground. This would explain the shift.

An even more ideal test of the mine shift hypothesis would be to look at numbers of mines in even narrower labor force size categories.

The data to do a finer test of the hypothesis were not available in a readily usable form. Therefore, using annual reports of state coal mining agencies for most of the states which had good data, I counted the number of mines in each category. The data to be presented should be taken with a grain of salt, however. The 1952 Act exempted mines with 14 or fewer workers regularly employed underground. Some of the state reports give only the total number of employees. They do not state how many of these employees were underground. This would tend to bias upward the stated size of a mine for our purposes. The results are given in Tables A-7 to A-11 (Kentucky),[10] Table A-12 (West Virginia), Table A-13 (Indiana) and Table A-14 (Ohio). They are grouped somewhat to facilitate comparison, although even more disaggregated data were collected. As can be seen from looking at the tables, the results lend slight support to the mine shift hypothesis. In Bell County, Kentucky (Table A-7), there was a trend decline in the number of mines in the 26 and over category and a shift out of the 15 and 17-20 category into the 13 category. In Floyd County, Kentucky (Table A-8), there was an increase in the number of mines in the five to nine and the 13 and 14 categories. In Harlan, Letcher, and Pike Counties,

Kentucky (Tables A-9 to A-11), there was no shift. In West Virginia (Table A-12), the number of mines in the one to five and six to 10 categories was relatively stable, while the number in the other categories declined. In Indiana (Table A-13), there was a shift out of the 17 to 25 category and into the six to 13 category. In Ohio (Table A-14) there was a significant decline in all categories except the 14, 15 and 16 categories. Given that the data are for the total number of underground workers, the result for Ohio tends to support the mine shift hypothesis. Some of the workers in the 14 to 16 size would have been surface workers. Therefore, the relative increase in the number of mines in the 14 to 16 worker category, would, when account is taken of the small component of surface workers in this total, imply a relative increase in the number of mines in approximately the 12 to 14 category. In sum, the results for this last test are not strong but do lend some support to the mine shift hypothesis.

One problem inherent in all the above tests is that they assume that a mine is a mine. That is, they assume that any mine with n men is the same as any other mine with n men. This is a poor assumption, since the outputs of same-sized mines can be radically different, due mainly to a different number of operating days. A way around this problem would be to do all the above tests with shares of output rather than shares of mines in various size classes. The data allowed all of these tests to be done except the last one above. To do this last would have required the outputs of mines in each category to be added. This would have consumed a few hundred hours of time. It appeared that the costs of this test exceeded the benefits. We turn now to the

results of the output share tests.

In Table A-15 is given the fraction of bituminous output produced in Title I, Title II and non-underground mines, respectively. The fraction of output produced in Title I mines rose from an average of .046 before the legislation to .085 after. The fraction of output from Title II mines fell from .720 to .616. The fraction of output produced in non-underground mines (strip and augur) rose from .233 to .300. That is, all the changes in fractions of output were in the right direction. Moreover, the differences in means were all significant. The differences in means were .039, -.104, and .67 and the differences required for significance were .010, -.031, and .12 respectively.

As was done earlier with the fraction of mines in each category, the test can be done with the fraction of output in each category for each state. The fractions of output produced in Title I, Title II and non-underground mines by state are presented in Tables A-16, A-17 and A-18 respectively. The mean fractions of Title I output, Title II output and non-underground output before and after the legislation and their differences are presented in Tables III-4, III-5, and III-6 respectively.[11] The results in general support the mine shift hypothesis.

In five states, Pennsylvania (bituminous), Tennessee, Virginia, West Virginia, and Pennsylvania (anthracite), the fraction of output produced in Title I mines increased significantly. In only two states, Alabama and Ohio, was there a significant decrease in this fraction. In Illinois, the fraction decreased but not significantly. In the remaining four states, Colorado, Indiana, Kentucky and Utah, the fraction of output produced in Title I mines increased but not significantly.

TABLE III-4: Mean Fraction of Output Produced in Title I Mines before and after Legislation, Differences between Means, and Differences Required for Significance, by State.

STATE	MEAN FRACTION BEFORE LEGISLATION	MEAN FRACTION AFTER LEGISLATION	DIFFERENCE IN MEANS	DIFFERENCE REQUIRED FOR SIGNIFICANCE
Alabama	.041	.027	-.014*	.008
Colorado	.075	.089	.014	.020
Illinois	.0055	.0044	-.0011	.0024
Indiana	.0090	.0100	.0010	.0034
Kentucky	.070	.079	.009	.014
Ohio	.029	.019	-.010*	.004
Penn. (Bit.)	.020	.027	.007*	.003
Tennessee	.073	.146	.073*	.059
Utah	.081	.117	.036	.046
Virginia	.038	.211	.173*	.042
West Virginia	.0108	.0318	.0210*	.0067
Penn. (Anthr.)	.018	.129	.111*	.032

*Indicates significance at 95% confidence level.

TABLE III-5: Mean Fraction of Output Produced in Title II Mines before and after Legislation, Differences between Means, and Differences Required for Significance, by State.

STATE	MEAN FRACTION BEFORE LEGISLATION	MEAN FRACTION AFTER LEGISLATION	DIFFERENCE IN MEANS	DIFFERENCE REQUIRED FOR SIGNIFICANCE
Alabama	.435	.417	-.018*	.014
Colorado	.404	.367	-.037*	.024
Illinois	.408	.345	-.063*	.021
Indiana	.293	.226	-.067*	.014
Kentucky	.379	.330	-.049*	.026
Ohio	.266	.209	-.057*	.025
Penn. (Bit.)	.412	.386	-.026*	.015
Tennessee	.404	.242	-.162*	.047
Utah	.919	.883	-.036	.046
Virginia	.418	.243	-.175*	.024
West Virginia	.466	.447	-.019*	.006
Penn. (Anthr.)	.620	.324	-.296*	.090

*Indicates significance at 95% confidence level.

TABLE III-6: Mean Fraction of Output Produced in Non-Underground Mines before and after Legislation, Differences between Means, and Differences Required for Significance, by State.

STATE	MEAN FRACTION BEFORE LEGISLATION	MEAN FRACTION AFTER LEGISLATION	DIFFERENCE IN MEANS	DIFFERENCE REQUIRED FOR SIGNIFICANCE
Alabama	.524	.556	.032*	.014
Colorado	.521	.544	.023*	.009
Illinois	.587	.650	.063*	.021
Indiana	.698	.765	.067*	.011
Kentucky	.551	.592	.041*	.016
Ohio	.705	.772	.067*	.026
Penn. (Bit.)	.568	.587	.019*	.010
Tennessee	.523	.612	.089*	.026
Utah	0	0	0	
Virginia	.543	.547	.004	.024
West Virginia	.523	.521	-.002	.011
Penn. (Anthr.)	.362	.548	.186*	.060

*Indicates significance at 95% confidence level.

In all 12 states (see Table III-5), there was a decrease in the fraction of output produced in Title II mines. In all states but Utah this decrease was significant. In 10 of the 12 states (see Table III-6), there was a significant increase in the fraction of output produced in non-underground mines. This increase was significant in all of these states but Virginia. Only in West Virginia was there a decrease in the share of non-underground output and this decrease was insignificant. Utah had no non-underground sector.

The fractions of total (underground and non-underground) output produced in mines with labor force sizes of one to four, five to nine, 10 to 14, 15 to 19, 20 to 24, 25 to 49, and 50 men and over are presented in Table A-19 (bituminous) and Table A-20 (anthracite). The mean and post-legislation fractions and their differences are presented in Tables III-7 and III-8 respectively.

The results do not support the hypothesis that the increase in output in mines in the 10 to 14 man category was large relative to the increase in output in the one to four and five to nine man category. Although the shares of output in the one to four, five to nine, and 10 to 14 man category increased significantly for both bituminous and anthracite, as predicted, the relative increase was largest for mines in the one to four man category, contrary to prediction. This result is not upsetting in the case of anthracite. As noted earlier, the Pennsylvania anthracite Act of 1953 which exempted mines with a labor force size of one to four men was probably the cause of the larger relative shift into this category. However, I have no good explanation of the failure of the hypothesis in the bituminous case.

TABLE III-7: Mean Fraction of Output Produced in Mines of Various Labor Force Sizes before and after Legislation, Differences in Means, and Differences Required for Significance, Bituminous.

LABOR FORCE SIZE (MEN)	MEAN FRACTION BEFORE LEGISLATION	MEAN FRACTION AFTER LEGISLATION	DIFFERENCE IN MEANS	DIFFERENCE REQUIRED FOR SIGNIFICANCE
1-4	.0060	.0193	.0133*	.0058
5-9	.0173	.0337	.0164*	.0062
10-14	.0175	.0256	.0081*	.0080
15-19	.0137	.0141	.0004	.0056
20-24	.0104	.0101	-.0003	.0018
25-49	.0381	.0345	-.0036*	.0028
50+	.646	.542	-.104*	.051

*Indicates significance at 95% confidence level.

TABLE III-8: Mean Fraction of Output Produced in Mines of Various Labor Force Sizes before and after Legislation, Differences in Means, and Differences Required for Significance, Anthracite.

LABOR FORCE SIZE (MEN)	MEAN FRACTION BEFORE LEGISLATION	MEAN FRACTION AFTER LEGISLATION	DIFFERENCE IN MEANS	DIFFERENCE REQUIRED FOR SIGNIFICANCE
1-4	.0009	.0551	.0542*	.0092
5-9	.0076	.0456	.0380*	.0119
10-14	.0099	.0296	.0197*	.0075
15-19	.0072	.0165	.0093*	.0051
20-24	.0077	.0096	.0019	.0080
25-49	.027	.026	-.001	.015
50+	.582	.237	-.345*	.092

*Indicates significance at 95% confidence level.

Nor do the results support the hypothesis that the decline in output was relatively larger in the 15 to 19 man category than in the 50 men and over category. On the contrary, there was an increase in the fraction of output produced in the 15 to 19 man category. In the case of anthracite this increase was significant. The decrease in the fraction of output was largest as a percent in the 50 and over category for both bituminous and anthracite. A possible explanation for this result is that although de jure all mines with 15 or more underground employees were regulated, de facto the regulators concentrated on regulating the largest mines. This would explain the large decrease in the share of output from mines with 50 men and over and the non-decrease in the share of output from mines with 15 to 19 men. However, data on inspections of mines do not exist to allow a test of this possibility.

One final test of the mine shift hypothesis was tried. If there had been a shift in the predicted direction, then one would expect that operators constrained to keep the underground work force below 15 men would increase the number of hours that each of these men worked.[12] Therefore the hours per day per worker in a Title I mine should have risen relative to the hours per day per worker in a Title II mine. Table III-9 shows that this did not occur.

On the basis of the above evidence, the hypothesis that mines and output shifted from the regulated Title II category to the unregulated Title I and non-underground categories in response to the 1952 Act has been strongly confirmed. However, the hypothesis that there was a larger relative shift of mines and output from the just over 14 man category to the just under 15 man category in underground

TABLE III-9: Average Hours per Day per Worker in Underground Bituminous Mines, 1950-1957.

SIZE (MEN)	1950	1951	1952	1953	1954	1955	1956	1957
1-4	7.69	7.81	7.88	7.87	7.88	7.77	7.85	7.77
5-9	7.79	7.84	7.92	7.94	7.94	7.88	7.87	7.93
10-14	7.83	7.84	7.93	7.93	7.92	7.90	7.89	7.92
15-19	7.84	7.84	7.92	7.91	7.90	7.90	7.92	7.94
20-24	7.83	7.83	7.84	7.87	7.92	7.94	8.00	7.93
25-49	7.85	7.87	8.06	7.91	7.93	7.86	7.89	7.91
50+	7.89	7.89	7.89	7.89	7.89	7.89	7.93	7.90

mining has been refuted.

The Injury Shift Hypothesis

Previous work has been done by Andrews and Christenson[13] on the effect of the 1952 Act on injuries. They regressed fatal and non-fatal injury rates per manhour on various technological variables and a dummy variable for the 1952 legislation. They failed to detect any effect of the Act. However, given the stated intent of the Act this is not surprising. Since the Act was aimed at preventing only a small subset of the accidents then occurring, it would be improbable to find an effect of the Act with the highly aggregated data that they used. Tests similar to theirs can be run using more disaggregated data. I disaggregated in two ways.

First, I looked at injury rates[14] in the regulated category of mines. I was able to divide mines into three categories -- mines of size one to nine, 10 to 24, and 25 and over. Mines in size 10 to 24 could be either Title I and Title II mines. Therefore, I chose to look at the other two categories. In Tables A-21 and A-22 are presented the fatality rates in mines of size one to nine men and in mines of size 25 men and over and their ratio, per million manhours worked and per million tons produced, respectively. In Tables A-23 and A-24 are presented the non-fatal injury rates in mines of size one to nine men and in mines of size 25 men and over and their ratio, per million manhours worked and per million tons produced, respectively.

If the Act had an effect on injuries, then one would expect the ratio of the injury rate in regulated mines to the injury rate in unregulated mines to fall after the legislation. Data from Table A-21

show than the mean ratio of the fatal injury rates per million manhours actually rose by .11 from .36 to .47. This increase was less than the .13 increased required for significance. From Table A-22, the mean ratio of the fatal injury rates per million tons fell by .003, from .300 to .297. This fall was trivial compared to the .099 fall required for significance. From Table A-23, the mean ratio of the non-fatal injury rates per million manhours rose from 1.17 to 1.26, although this increase of .09 was less than the increase of .20 required for significance. Finally, from Table A-24, the mean ratio of the non-fatal injury rates per million tons fell from .96 to .80, but this decrease of .16 was less than the decrease of .21 required for significance. In short, injury rates in regulated mines did not fall relative to injury rates in unregulated mines after the introduction of regulation.

The second way to disaggregate is to look at the categories of injuries regardless of mine size.[15] As was stated earlier, the data can be broken down into injuries that the Act was aimed at reducing and injuries that the Act was not aimed at reducing. The ratio of the former to the latter should have decreased if the Act was successful in reducing injuries. In Tables A-25 and A-26 are presented data on the number of fatal injuries and number of non-fatal injuries, respectively, in the categories regulated by the 1952 Act and not regulated by the 1952 Act, and the ratio of the number of regulated injuries to the number of unregulated injuries. The mean ratio of regulated fatalities to unregulated fatalities fell from .186 before the Act to .161 after the Act. However, this fall of .023 was small compared to the decrease of .107 required for significance. The mean ratio of regulated non-

fatal injuries to unregulated non-fatal injuries rose from .0312 before the Act to .0423 after the Act. This increase of .0111 was large compared to the increase of .0026 required for significance. Clearly, the 1952 Act caused no significant reduction in injuries.

The Costs and Benefits of the 1952 Act

The evidence is conclusive enough for one to say that there was a shift of mines and production from the regulated to the unregulated sector. There were costs of this shift which there is no apparent way of estimating. There were other costs of the 1952 Act. In 1957, a typical year, Congress appropriated $4,893,354 for enforcing the Act.[16] Another cost was the cost of debating over and passing the legislation. There was a cost to participants in the hearings, a cost to the government of printing copies of the hearings, and finally, a cost to Congressmen of using their time to attend the hearings. However, since the cost of a resource is reckoned at the value of its highest-valued alternative use, it is not clear whether the cost of Congressmen's time was positive or negative. Whether it was positive or negative depends on what they would have done with their time in the absence of the mine safety bill. They might have used their time to enact legislation which imposed net costs on "society." In this case, the social cost of their time would have been negative.[17]

The potential area for direct benefits of the Act was in injury reduction. As was shown above, the Act did not appear to have reduced injuries. Therefore, the direct benefits of the Act were zero.

FOOTNOTES

1. See U.S., Congress, House, Committee on Education and Labor, Coal Mine Safety, Hearings before Subcommittee on Coal Mine Safety on H.R. 268, 82d Cong., 2d sess., 1952, p. 41.

2. This code appeared in the "contract" between Interior Secretary Krug and UMW President John L. Lewis. It was subsequently retained in the United Mine Workers' contract with coal mine operators even after the federal government gave up control of the mines.

3. See U.S., Congress, House, Committee on Education and Labor, Hearings on H.R. 7408, 82d Cong., 2d sess., 1952.

4. See U.S., Department of Interior, Bureau of Mines, Injury Experience in Coal Mining, 1953-54. Information Circular, 1958, p. 98.

5. For the whole act, see Pub. L. 77-552 (July 16, 1952), Federal Coal Mine Safety Act, amendment. 66 Stat. 692.

6. Henceforth, underground mines with fewer than 15 underground workers will be called Title I mines or small mines and mines with 15 or more workers will be called Title II mines or large mines.

7. The test was taken from William Mendenhall and Richard Scheaffer, Mathematical Statistics with Applications (North Scituate, MA: Duxbury Press, 1973), pp. 286-288.

8. The eleven bituminous-producing states for which the data are reported account for almost all bituminous coal production. For instance, in 1950, they accounted for 95 percent of the national output of bituminous coal. Anthracite is mined only in Pennsylvania.

9. All post-legislation means are calculated from 1956 on in order to allow for a period of adjustment.

10. Data are presented for the major underground coal producing counties of Kentucky. There appeared to be enough mines in each of the five counties to justify treating each county as a sample point.

11. In all the tests on differences in means before and after legislation done in this Chapter, the years from 1953 to 1955 are excluded from the post-legislation mean in order to allow for a period of adjustment to the legislation.

12. I thank Ms. Robin McNamara for pointing out this implication.

13. W.H. Andrews and Carroll L. Christenson, "Some Economic Factors Affecting Safety in Underground Bituminous Coal Mines," Southern Economic Journal 40 (January 1974): 364-376.

14. I looked at both fatal and non-fatal injury rates. Although the stated purpose of the Act was to prevent major disasters in which workers were killed, safety requirements which prevented fatalities should also have prevented non-fatal injuries. Therefore, the effect of the Act should show up in the non-fatal injury data.

15. Of course, ideally one would like to look at the data disaggregated by both mine size and category of injury. This was not possible however.

16. See U.S., Bureau of the Budget, The Budget of the United States Government for the Fiscal Years Ending June 30, 1959, 1958, p. 673. Not all of this appropriation was necessarily a cost. As noted in footnote 7 the inspections in themselves might have provided valuable information about unsafe conditions, allowing the coal mine operator not to invest in such information.

17. Flippant as this point may sound, it is a very important one which is not in general taken account of by economists. A similar problem often arises in a slightly different context. Economists who calculate the social loss from a tax generally calculate the producer and surplus loss and subtract the revenue obtained by the government. Such analysis assumes that the government uses the revenue for ends that are socially as valuable as the ends to which the taxed individuals would have devoted the revenue. No good reason is generally given for this assumption.

CHAPTER IV

THE EFFECTS OF THE 1966 AND 1969 LEGISLATION

The Federal Coal Mine Safety Act Amendments of 1965

Background

Throughout the late 1950's and early 1960's, there were many Congressional attempts to eliminate the exemption of small underground mines from federal safety regulation. Bills were introduced to eliminate the exemption in 1958, 1959, 1961 and 1963.[1] In fact, the 1963 Bill, S. 743, passed the Senate but died in the House of Representatives. Meanwhile, President Kennedy appointed a Task Force on Coal Mine Safety which recommended in August 1963 that the exemption for small mines be removed.[2] Finally, the Amendments of 1965 were passed by the House on June 1, 1965 and by the Senate on March 14, 1966. The Bill was signed into law on March 26, 1966.[3]

The Terms of the Amendments

The main thrust of the Act was the repeal of the exemption for small mines. However, a new subsection, 203(d) was added to the 1952 Act which provided for a reinspection closing order to prevent recurring violations of Section 209 of the Act. Under this subsection, if an inspector found that any provision of Section 209 was being violated but the violation did not cause imminent danger of a mine explosion, mine fire, mine inundation, or man-trip or man-hoist accident, he was now required to give the operator 90 days to abate the violation. Formerly, under the 1952 Act, the operator was to be given a

"reasonable" amount of time to abate the violation, and the amount of time was at the discretion of the inspector. Finally, Sections 205 (a), (b), (c) and (d) were amended to reconstitute the Federal Coal Mine Safety Board of Review. It was to consist of five instead of three members. One member each was to represent the viewpoint of the big mine operators, the big mine workers, the small (formerly Title I) mine operators, and the small mine workers respectively. As before, the fifth member was to be a neutral engineer with experience in the coal mine industry.

As with the 1952 Act, one would expect the 1966 legislation to have an effect on the size distribution of mines and on fatal and non-fatal injuries. I turn now to an examination of these effects.

The Mine Shift Hypothesis

Mines with fifteen or more underground workers were subject to only one new regulation under the legislation, that is, the reinspection closing order. Mines with 14 or fewer workers were subjected to the reinspection closing order plus the other regulations from which they had been exempt. Therefore the cost of operating a mine with 14 or fewer workers fell relative to the cost of running a mine with 15 or more workers. One would expect a fall in the number of mines due to the increased cost of mining for all labor force sizes. Furthermore, one would expect a fall in the number of mines with 14 or fewer workers relative to the number of mines with 15 or more workers due to the increase in the relative cost of mining with 14 or fewer workers. This fall would have come about for two reasons. Some mines with 14 or

fewer workers would have gone out of business if the cost of compliance or of paying fines for non-compliance with the regulations exceeded the rents to mining. Other mine operations who were keeping the underground labor force below 15 men in order to avoid compliance with the 1952 Act would have found it worthwhile to expand their labor force to a size greater than 14 men. Both effects would have lowered the ratio of small to large mines. There is no way of predicting whether the number of mines in, say, the one to 10 man category would have fallen relative to the number in the 11 to 14 man category. One would expect the number of mines in the 11 to 14 man category to have fallen due to the increased cost of mining and due also to the elimination of the incentive to keep the labor force just below 15 men. Mines in the one to 10 man labor force size obviously were not constrained by the cutoff at 15 men. This suggests that there would have been a relatively larger shift out of the 11 to 14 man size. However, there could have been economies of scale in compliance in the sense that the cost of complying with the Act in a mine with 2n men was less than double the cost of complying in a mine with n men. This factor would have tended to decrease the number of smaller mines. The net effect on the relative decreases would be ambiguous.

Since the 1969 Act followed close upon the 1966 Act I shall postpone an examination of the data on the size distribution of mines until the section on the 1969 Act.

The Injury Shift Hypothesis

One would expect, if the 1966 legislation achieved what its proponents claimed for it, namely, a decrease in the accident rate in mines

with 14 or fewer workers relative to what would have occurred in the absence of the legislation, that the result would show up in a regression analysis. In an earlier study by Witt, Palomba and Palomba,[4] the authors regressed various measures of the non-fatal injury and fatal injury rate on technological determinants of injuries and a dummy variable for the 1966 Act.[5] In the case of non-fatal injuries they found no significant effect of the legislation at the .05 level. In the case of fatalities, however, they found a significant positive effect of the legislation. That is, their regression analysis suggested that the Act significantly increased fatalities per manhour. However, the above authors tested for the effect of the legislation on injury rates for the whole bituminous underground sector, in spite of the fact that the main provisions were directed at mines with 14 or fewer workers. I took a somewhat different approach. Although data were not available on injuries for mines with one to 14 workers after 1962, such data were available for mines with one to nine workers, 10 to 19 workers, and 20 or more workers. I used annual data for the period from 1950 (the year such data became available) to 1965 to fit an equation to explain the injuries (fatal and non-fatal) in mines with one to nine workers.

The best fit for the fatalities was given by the equation,

$$(4\text{-}1) \qquad \underset{}{FAT} = \underset{(.27)}{6.73} + \underset{(1.35)}{.91\ TON} + \underset{(2.04)}{31.58\ FATT20}$$

$$R^2 = .25$$
$$DW = 1.42$$
$$N = 16.$$

where FAT is the number of fatalities in a given year in mines of size one to nine men, TON is the total tonnage in mines of size one to nine men, and FATT20 is the number of fatalities per million tons in mines with 20 or more men. TON is in the equation to capture the effect of the size of the small mine sector on fatalities. The expected sign is positive since with more production, one would expect more accidents. FATT20 is a proxy for factors which affect fatalities in both small and large mines in the same direction. The expected sign is positive. Both signs are consistent with expectations.

There are two good fits for the non-fatal injury equation. The first was

$$(4\text{-}2) \qquad \underset{}{NFAT} = \underset{(1.67)}{264.2} + \underset{(4.14)}{28.9}\ MHR$$

$$R^2 = .55$$
$$DW = 1.48$$
$$N = 16.$$

where NFAT is the total number of non-fatal injuries in mines of size one to nine men in a give year and MHR is the number of manhours spent in such mines in the year. MHR has the same function as TON in equation (4-1). That is, the more manhours that are spent, the higher the expected number of non-fatal injuries. The variable NFH20, the number of non-fatal injuries per million manhours in mines with 20 or more men, was used as an additional independent variable for the same purpose as FATT20 in equation (4-1), but was very insignificant (with a t-statistic of -.012) and had the wrong sign. The sign on MHR is in the predicted direction.

The other equation fit was,

$$(4\text{-}3) \qquad \underset{}{NFAT} = \underset{(.60)}{221.8} + \underset{(2.47)}{24.62}\ TON + \underset{(1.10)}{5.13}\ NFT20$$

$$R^2 = .47$$
$$DW = 1.68$$
$$N = 16.$$

where NFAT and TON are as before and NFT20 is the non-fatal injury rate in mines with 20 or more men. The signs on the independent variables are in the predicted direction. In all three equations the t-statistics are in parentheses.

These equations were then used to predict the number of fatal and non-fatal injuries that would have occurred in mines with a labor force of size one to nine men in the absence of the 1966 legislation. Predictions were made for the years 1967, 1968 and 1969 and were compared to the actual number of fatal and non-fatal injuries. A comparison of the predicted and actual values of the variables is presented in Table IV-1. As can be seen, all three equations overpredict the number of injuries. Although equation (4-3), is the only equation which significantly overpredicts injuries at the 95 percent confidence level (the t-statistics have to exceed 2.18 for significance for equations (4-1) and (4-3) and 2.16 for equation (4-2)) equations (4-1) and (4-2) do significantly overpredict at the 80 percent confidence level (for which the t-statistics have to exceed 1.36 and 1.35 respectively).

Another method used to test for the effect of the 1966 Act on injuries in mines of size one to nine men was to compare the ratio of injury rates in such mines to injury rates in mines with 20 or more

TABLE IV-1: Predicted and Actual Injuries for Mines with One to Nine Men for the Period 1967-1969.

(1) EQUATION	(2) YEAR	(3) PREDICTED VALUE	(4) ACTUAL VALUE	(5) STANDARD ERROR OF PREDICTION	$\left(= \frac{(4)-(3)}{(5)}\right)$ T-STATISTIC
4-1	1967	39.6	21	12.5	-1.49
	1968	48.4	25	11.2	-2.09
	1969	35.5	16	13.6	-1.43
4-2	1967	670.3	458	124.1	-1.71
	1968	605.0	412	132.1	-1.46
	1969	579.9	386	135.6	-1.43
4-3	1967	838.3	458	144.3	-2.64*
	1968	811.7	412	149.7	-2.67*
	1969	793.6	386	152.0	-2.68*

*Indicates significance at 95% confidence level.

men before and after the legislation. The ratios of the fatality rates and of the non-fatal injury rates and their differences are given in Tables IV-2 and IV-3, along with the pre- and post-legislation means of these rates. Both ratios of the fatality rates and one measure of the non-fatal injury rate are significantly lower in the post- than in the pre-legislation period. This test lends further support to the conclusion that the 1966 Act resulted in a reduction of injuries. An assessment of the value of this reduction is postponed until the end of the Chapter. I turn now to the 1969 Act.

The Federal Coal Mine Health and Safety Act of 1969

After the gas explosion which killed 78 men in a gassy bituminous coal mine in Farmington, West Virginia in November 1968, there was a clamor for stronger federal regulation of coal mines. It is not clear that those who clamored for the legislation were influenced by the Farmington disaster, however. The disaster occurred in an underground coal mine which was already under federal regulation. Moreover, the stated purpose of the already existing 1952 Act was to prevent such major disasters. In the Hearings on the 1952 Act, officials of the Bureau of Mines had justified the powers they were seeking on the ground that with such powers they would be able to prevent gas explosions in gassy mines such as the one which they failed to prevent in Farmington, West Virginia. In fact, much of the content of the 1969 Act had no conceivable connection with the Farmington disaster. Strip mines were brought under federal regulation[6] even though the Farmington mine was underground. The distinction which had heretofore existed in the regulation of gassy versus and non-gassy mines was

TABLE IV-2: Ratio of Fatality Rates in Mines with a Labor Force of One to Nine Men to Fatality Rates in Mines with 20 or More Men, 1950-1969.

YEAR	FATALITIES PER MANHOUR, 1-9 / FATALITIES PER MANHOUR, 20+	FATALITIES PER TON, 1-9 / FATALITIES PER TON, 20+
1950	4.31	5.33
1951	2.07	2.62
1952	2.21	2.91
1953	2.82	3.93
1954	2.75	4.14
1955	2.72	3.88
1956	2.24	3.13
1957	2.08	2.81
1958	3.09	4.89
1959	2.01	3.21
1960	3.39	3.48
1961	2.12	3.95
1962	1.56	2.69
1963	1.40	2.40
1964	2.18	3.30
1965	1.51	3.07
1966	2.28	3.52
1967	1.52	2.28
1968	1.27	1.70
1969	1.80	2.29
Mean (1950-1965)	2.46	3.48
Mean (1967-1969)	1.53	2.09
Difference in Means	-.93*	-1.39*

*Indicates significance at 95% confidence level.

TABLE IV-3: Ratio of Non-Fatal Injury Rates in Mines with One to Nine Men to Injury Rates in Mines with 20 or More Men, 1950-1969.

YR.	NON-FATAL INJURIES PER MANHOUR, 1-9 / NON-FATAL INJURIES PER MANHOUR, 20+	NON-FATAL INJURIES PER TON, 1-9 / NON-FATAL INJURIES PER TON, 20+
1950	.93	1.15
1951	.91	1.16
1952	.87	1.15
1953	.97	1.35
1954	1.03	1.55
1955	.74	1.06
1956	.60	.84
1957	.80	1.09
1958	.80	1.26
1959	.83	1.33
1960	1.40	1.44
1961	.88	1.64
1962	.85	1.47
1963	.84	1.44
1964	1.01	1.53
1965	.76	1.54
1966	.69	1.06
1967	.66	1.00
1968	.71	.95
1969	.71	.90
Mean (1950-1965)	.89	1.31
Mean (1969-1969)	.69	.95
Difference in Means	-.20	-.36*

*Indicates significance at 95% confidence level.

almost entirely eliminated even though the explosion had occurred in a gassy mine. The regulation of other causes of more mundane day-to-day accidents was increased. Finally, regulations were introduced to lower the dust level in the air and therefore hopefully the incidence of black lung (pneumoconiosis) even though this had no connection with the Farmington disaster. I turn now to the specifics of the Federal Coal Mine Health and Safety Act of 1969[7] as they relate to underground bituminous coal mines.

Title II of the Act set interim mandatory health standards for underground coal mines. Coal mine operators were required to take samples of respirable dust on a regular basis to assure that the level of dust was below 3.0 milligrams per cubic meter of air. The maximum level was to fall to 2.0 mg. per cubic meter of air after three years. Operators were not allowed to have workers use respirators as an alternative to meeting the dust level standard, even though respirators would be a lower cost way of achieving the lower incidence of black lung. The main reason given by Dr. Lorin Kerr, who represented the United Mine Workers union at the Hearings, for his opposition to the use of respirators was that "their use does not encourage the elimination of dustiness in the mines."[8] There would be spot inspections by Bureau of Mines officials to obtain compliance with the dust level standards. Within six months of the Act's passage, the Secretary of the Department of Health, Education and Welfare was to promulgate and enforce maximum noise levels.

Title III set interim mandatory safety standards for underground coal mines. Under this title, there was detailed regulation and

specification of the production function for safety. Roof support was required for all active underground roadways, travelways, and working places. All coal mines had to be ventilated with a minimum quantity of air equal to 9000 cubic feet per minute. A line brattice was required from the last open crosscut of an entry or room of each working section to provide ventilation to the working faces. There was to be an examination for methane before and during each shift. A more general examination for hazardous conditions was required on every shift and withdrawal of workers was required if this examination yielded positive results. Tests for methane were required every 20 minutes where electrical equipment was used. Even where electrical equipment was not used, workers were to be withdrawn if the test registered over 1.5 percent methane.

The Act contains over eight pages of detailed regulation of electrical equipment. Almost all electrical equipment was required to be permissible. That is, the gassy-non-gassy distinction was almost entirely removed. However, some of the provisions requiring permissible equipment in formerly non-gassy mines were grandfathered. Specifically, non-permissible equipment presently in use in a non-gassy mine could be used until it wore out.

The Act also contains requirements for fire-fighting equipment, maps, storage of explosives, hoists and mantrips, emergency shelters, two-way telephone service between the surface and each working section, fire-proof construction of surface structures, at least two exits from each working section of the mine, and underground toilets.

Title IV provided for federal subsidy to people permanently disabled by black lung and to widows of workers who had died of black lung, for all claims filed up to December 31, 1972.[9] After this date, black lung payments were to be paid from workmen's compensation plans.

Title I of the Act provided for increased health standards in the future, mine inspections, withdrawal orders, appeal of decisions, penalties for violations, and compensation of miners in the event of the temporary shutdown of a mine.

The Secretary of the Interior was to promulgate improved health and safety standards and was not allowed to set the standards below the interim standards required under Titles II and III.

Each mine was to be inspected four times per year. In the case of imminent danger, the inspector was required to issue a withdrawal order stating that no one could enter the area until the danger was eliminated. If the danger was not imminent but nevertheless could contribute to a health or safety hazard, and if this danger was due to non-compliance with mandatory standards, then the inspector was also required to issue a withdrawal order. This represents an increase in powers given the inspector. Formerly in such a case, the inspector was required to give the operator 90 days to correct the condition but could not require immediate withdrawal of workers. Upon application of the operator or a representative of the workers within 30 days of the receipt of the withdrawal order, there was to be a hearing before an official of the Bureau of Mines who was to make the final decision. If the person who requested the hearing still was not satisfied, then

he could appeal to the United States circuit court of appeals in the area.

The maximum penalty for a violation of a mandatory health or safety standard was set at $10,000 for each violation. Each occurrence of a violation was to constitute a separate offense. If an operator willfully violated a mandatory health or safety standard, or knowingly violated a withdrawal order, he was to be fined, upon conviction, up to $25,000 and imprisoned for up to one year, or both. The penalty for a second or later conviction was set at a maximum fine of $50,000 or up to five years in prison, or both. If coal mines or sections of coal mines were closed by a withdrawal order, the operator was required to pay the workers for the full shift's wages. If the coal mine or a section of the coal mine were closed by a withdrawal order for an unwarrantable failure of the operator to comply with any health or safety standard, all miners idled by the closing were to be fully compensated for as long as they were idled or a week, whichever was less.

In short, the 1969 Act was much more stringent than earlier legislation. I turn now to an examination of the effects of the Act.

The Mine Shift Hypothesis

To the extent that there are economies of scale in compliance with the Act, in the sense mentioned earlier in this Chapter, the relative cost per worker of compliance with the Act would be higher the smaller the mine. Are there economies of scale in compliance? Most likely there are. Ventilation, emergency shelters, fire-fighting equipment, and two-way telephones are all requirements which would be more costly per worker the fewer the workers. Also, the requirement of two exits

from each working section of a mine would impose a larger burden on small mines. In the words of John O'Leary, the Director of the Bureau of Mines who testified in favor of the Act,

> The larger mines have, generally speaking, a number of ways in and out and would be unaffected by this. Some of the very small mines,..., would have to add a second way out if this went into effect... By and large this would not represent, I think, a major economic burden on a large segment of the industry. Its influence would be on the narrower section of the industry, although it would be a major item of expense.[10]

Finally there would be gains from specialization of labor in complying with the Act (measuring methane, measuring coal dust, roof bolting, etc.), which small mine operators would have to forego. Another factor making the cost of compliance the with new Act relatively higher per worker for smaller mines was the removal of the gassy-non-gassy distinction. Incidentally, it is difficult to believe that the removal of this distinction was motivated by a desire for increased safety. From June 1952 until September 10, 1969, there were only 55 ignitions and explosions in non-gassy mines.[11] Of these, only 11 were due to the use of non-permissible equipment. Although 19 workers were injured by these 11 explosions, none were killed. Moreover, in the words of the Senate report on the bill,

> During the course of the committee consideration of the bill, representatives of the Department of the Interior stated to the committee that there had never been an ignition in a non-gassy mine caused by any large piece of equipment which did not meet the Department's standards for explosion and ignition prevention. The Department representative warned, however, that, "We have just been lucky. One of these days, we will have a disaster."[12]

Apparently, the more than one billion manhours[13] of safe experience with large equipment in underground mines was not enough to convince

this official that something other than luck was afoot.

In any case, it is clear how a requirement that non-gassy mines use permissible equipment would result in a decrease in the number of non-gassy mines. But would it result in a relative decrease in the number of small mines? Yes. The reason is that large mines tend to be gassy and small mines to be non-gassy. The reason small mines are generally non-gassy is that they do not penetrate nearly as far into the hill and therefore gas cannot build up as easily.[14] In 1968, the average size of a non-gassy mine was approximately one ninth that of a gassy mine.[15] Therefore, the elimination of the gassy-non-gassy distinction would hit small mines harder.

The evidence for the claim that both the 1966 and the 1969 Acts resulted in a relative decrease in the number and output of small mines is strong. In Tables A-27 to A-34 in the Appendix, are presented the number of mines in various labor force size categories in various states and counties over the period of concern. As in Chapter III, five counties in Kentucky had enough mines that each county could be counted as a separate observation. In three of the five Kentucky counties (Bell, Harlan, and Pike) and three states (Ohio, Alabama, and West Virginia) there was a dramatic decrease in the number of small mines relative to the number of large mines. In two Kentucky counties the number of small mines fell relative to the number of large mines, but not as dramatically. Since the data do not consistently give the number of workers employed underground as distinct from the number employed both underground and above ground at underground mines,[16] a finer test of the hypothesis that the 1966 Act should shift mines from

the 14 worker or slightly fewer category to the 15 worker or slightly more category was impossible.

What was the effect of the 1966 Act[17] on the relative output, as opposed to the relative number, of small mines? Figure IV-1 reveals that the fraction of underground output produced by underground mines with a labor force of size one to nine men trended upward after passage of the 1952 Act and then dropped steadily starting in 1966. Presumably the drop was steady from 1966 rather than a one-time shift because some provisions of the Act were "grandfathered." This result is striking evidence for the conclusion that the 1966 Act caused a decline in the fraction of output produced by small mines.

Further evidence on the shift from small to large mines is given in Table IV-4. This table gives the number of underground bituminous mines and the number of men employed per underground bituminous mine over time. Starting in 1966 the number of mines fell dramatically and the number of men per mine rose dramatically. Thus the decrease in the number of mines must have been due to mainly the exit of small mines.

I have found only one piece of evidence inconsistent with the hypothesis that the 1966 Act caused a shift from small to large mines. In Chapter III it was stated that if mine-owners after the 1952 Act but before the 1966 Act really were constrained by the legislation to keep their labor force below 15 men, then the number of hours worked per day per worker should increase.[18] Similarly, once the 1966 Act came into effect, mine operators would no longer be constrained and therefore the number of hours per day per worker should fall in small

FIGURE IV-1: Output share of bituminous underground mines in one to nine man size category, 1948-1970.

TABLE IV-4: Number of Mines and Number of Men per Mine in Underground Bituminous Mines, 1953-1973.

YEAR	NUMBER OF UNDERGROUND BITUMINOUS COAL MINES	NUMBER OF MEN EMPLOYED PER UNDERGROUND BITUMINOUS MINE
1953	6783	39.2
1954	6270	34.5
1955	6845	29.1
1956	7293	27.4
1957	7078	27.8
1958	7381	23.2
1959	7101	21.8
1960	7392	19.7
1961	6796	18.9
1962	6899	17.9
1963	7082	16.9
1964	6410	17.8
1965	6229	18.2
1966	5243	20.0
1967	4449	22.6
1968	3850	25.0
1969	3450	27.7
1970	3053	32.9
1971	2268	48.2
1972	1996	56.2
1973	1737	64.0

mines. Table IV-5 presents evidence that this did not happen. Note however that the number of hours per day per worker is not very different from eight. It could be the case that the mine operators were constrained by maximum hour legislation. If the cost of enforcing this constraint were high,[19] operators might ignore it. However, their ignoring of the law would not show up in the records on manhours. Few operators would be stupid enough to report to one government agency that they were breaking the laws enforced by another government agency.

To conclude, the evidence is supportive of the hypothesis that the 1966 and 1969 Acts resulted in a relative decline in the number and output of small mines.

The Effect of the 1969 Act on Injury Rates

The hypothesis to be tested here is the hypothesis that the 1969 Act resulted in a reduction of injury rates in underground bituminous coal mining. Two previous studies have been done on this issue. Nelson and Neumann[20] set up a neo-classical model of safety and used it to predict the number of injuries (fatal plus non-fatal) in the post-1969 period. They found no effect. However, the problem was that the Bureau of Mines revised its system of reporting injuries. After April 1972, the Bureau of Mines reported as injuries incidents which would not have been so reported before April 1972.[21] Therefore, as the authors point out, their predicted number of injuries cannot be meaningfully compared to the actual number reported. Discussion with one of the authors revealed that the data required to do the test correctly are very difficult, if not impossible, to obtain. Moreover, they were further ahead than I at obtaining them from Mining

TABLE IV-5: Hours per Day of Operation of Underground Bituminous Mines in Various Size Categories, 1963-1969.

LABOR FORCE SIZE (MEN)	1963	1964	1965	1966	1967	1968	1969
1-4	7.88	7.92	7.91	8.02	7.88	7.89	7.93
5-9	7.94	7.96	7.96	7.96	7.92	7.95	7.97
10-19	7.95	7.95	7.97	7.98	7.99	7.99	8.01
20-49	7.95	7.97	7.97	7.99	8.00	7.97	7.98
50+	7.92	7.94	7.95	7.98	7.97	7.98	7.97

Enforcement and Safety Administration (MESA)[22] officials. Therefore, I decided not to test for the effect of the Act on non-fatal injuries. Since obviously the system of reporting fatalities was not changed, I tested for the effect on fatality rates.[23]

The approach I took was more simple-minded that the approach in either of the other papers. First, I had to choose whether the relevant fatality rate was the rate per manhour or per ton. I chose the latter. The reason is that although from the worker's point of view the mine is safer if the fatality rate per manhour is lower, looking at the fatality rate per manhour can mislead one about the salutary effects of legislation. To the extent that the Act requires work time to be devoted to compliance, and to the extent that time spent complying is safer than time spent producing coal, one would expect the Act to result in a lower fatality rate per manhour worked even if it resulted in no increase in safety for time spent producing coal.

To take a simple example, if the legislation required that two hours of every eight hour shift be spent complying, if time spent complying were completely injury-free, and if the injury rate predicted in the absence of the legislation were 1.00 death per million manhours, then one would be very surprised if the actual death rate were not less than or equal to .75 deaths per million manhours. This lowering of the death rate would be a consequence of the legislation but it would be nothing to be proud of. It could be achieved at lower cost by requiring coal mine operators to overstate manhours worked by 33 percent. The fatality rate per million tons would not be subject to this problem.

There is good evidence that the 1969 Act required a lot of time to be spent complying with the regulations which did not decrease the fatality rate for time actually spent producing coal. Figure IV-2 is a graph of the fatality rate per million manhours. Clearly, this rate fell after 1970.

The apparent fall was confirmed with regression analysis. Equation (4-4) was fit for the period 1940 to 1969 and used to predict the fatality rate per thousand manhours for the years 1970 to 1973. The predicted values were compared to the actual values. Equation (4-4) was,

$$\underset{}{\text{FATMHR}} = \underset{(16.17)}{.0135} \; \underset{(-1.87)}{- .0000088} \; \text{TIME}$$

$$R^2 = .11$$
$$DW = 1.14$$
$$N = 30,$$

where TIME is a linear time trend, and t-statistics are in parentheses.

The values of the predicted and actual fatality rates per thousand manhours are given in Table IV-6.

For the years 1971 to 1973 the predicted fatality rate per manhour was below the actual, and significantly so in 1973. This is not in itself evidence that the time was spent complying rather than that producing coal was actually safer. This conclusion requires Figure IV-3 which plots the fatality rate per million tons against time. The fatality rate per million tons was trending downwards before the 1969 Act and continued its decline after the Act. According to Figure IV-3, the 1969 Act did not significantly decrease the fatality rate per ton of coal produced.

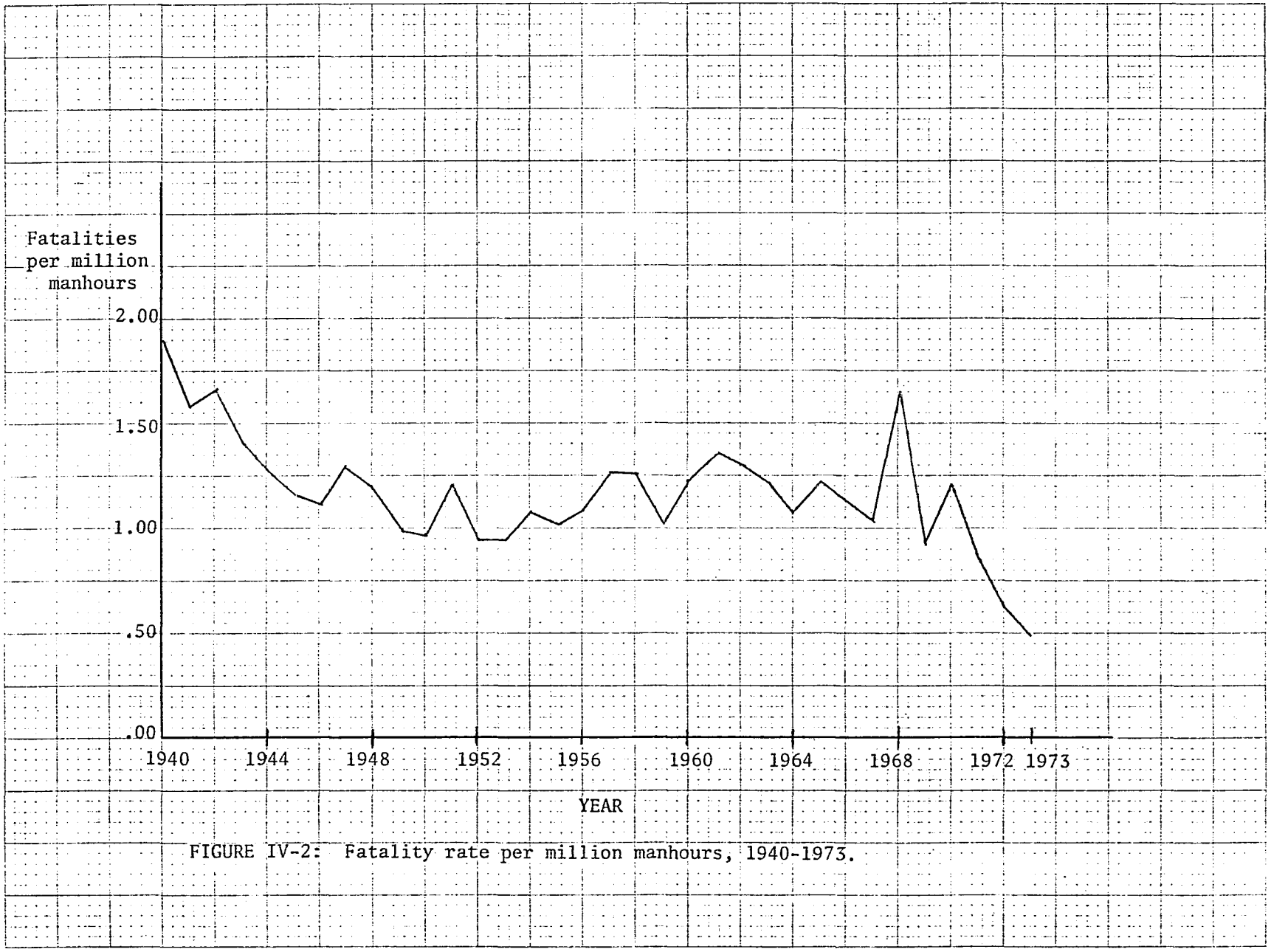

FIGURE IV-2: Fatality rate per million manhours, 1940-1973.

TABLE IV-6: Predicted and Actual Values and Confidence Intervals for the Fatality Rate per Thousand Manhours 1970-1973.

YEAR	PREDICTED VALUE	ACTUAL VALUE	95% CONFIDENCE INTERVAL
1970	.00108	.00121	(.00059, .00157)
1971	.00107	.00086	(.00058, .00156)
1972	.00106	.00062	(.00057, .00155)
1973	.00105	.00049*	(.00056, .00154)

*Indicates significance.

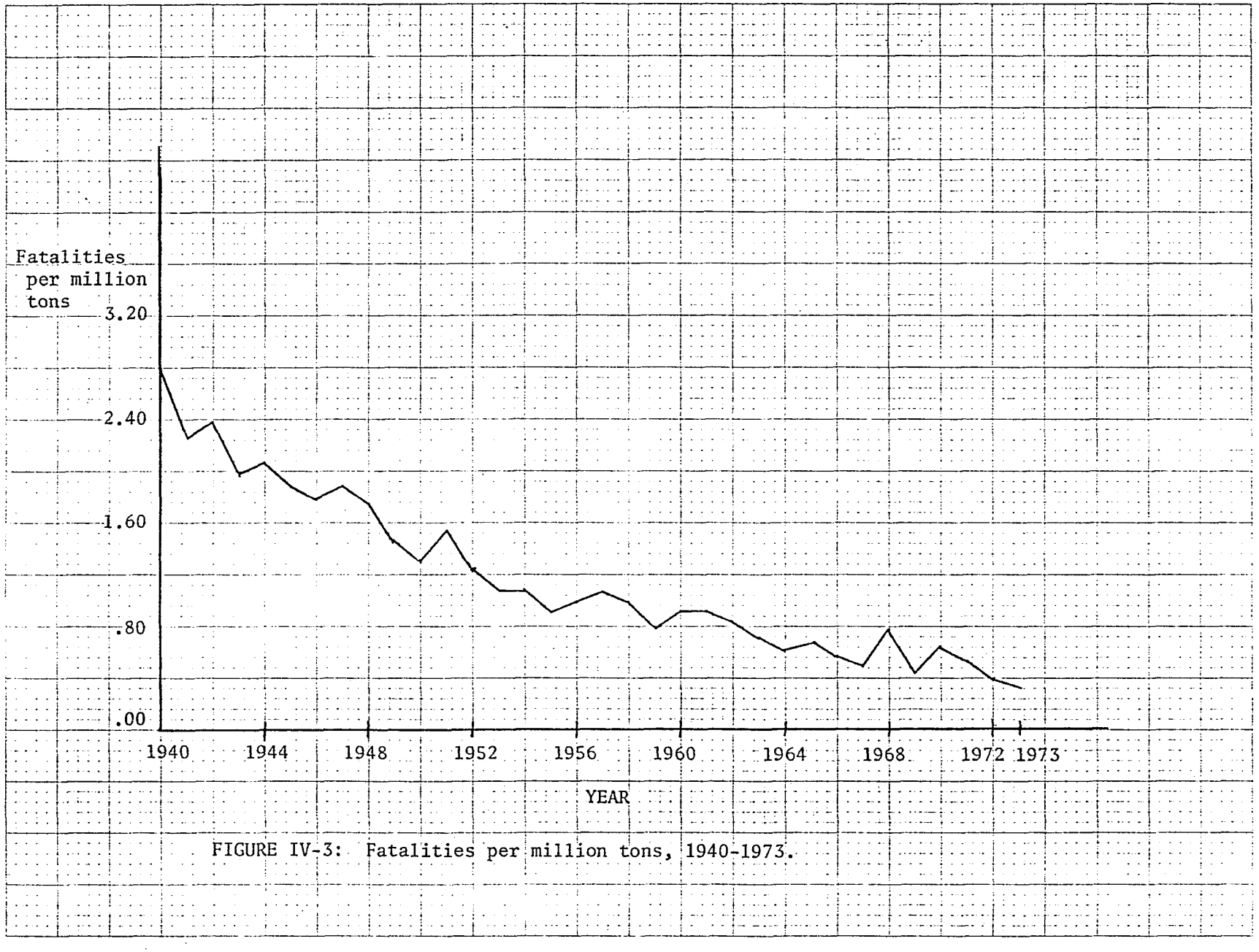

FIGURE IV-3: Fatalities per million tons, 1940-1973.

This result with the fatality rate per million tons was confirmed with regression analysis. The shape of the curve in Figure IV-3 suggested that the appropriate equation to fit to the period from 1940 to 1969 was a log-linear equation. The equation fit was,

$$(4\text{-}5) \qquad \underset{}{LFTON} = \underset{(-129.3)}{-5.94} - \underset{(-20.48)}{.053}\ TIME$$

$$R^2 = .94$$
$$DW = 2.28$$
$$N = 30,$$

where LFTON is the log of the fatality rate per million tons of coal produced and TIME is a linear time trend. This equation was then used to predict what the fatality rate would have been in the absence of the legislation. The predicted values were then transformed by an exponential operation, as were the extrema of the 95 percent confidence interval. The predicted values, confidence intervals and actual values are presented in Table IV-7. In 1970 and 1971 the predicted rate was below the actual rate, but not significantly, while in 1972 and 1973, the predicted rate was above the actual rate, but not significantly. This confirms the visual impression from Figure IV-3 that the 1969 Act had no significant effect on the relevant fatality rate in underground bituminous mines. Therefore, the fall in the fatality rate per manhour must have been due to time devoted to complying with the Act.

The Effect of the 1969 Act on Labor Productivity

It is a truism that if the fatality rate per ton fell but the fatality rate per manhour fell even more, then tons per manhour fell.

TABLE IV-7: Predicted Values, Actual Values, and Confidence Intervals for the Fatality Rate per Million Tons, 1970-1973.

YEAR	PREDICTED RATE	ACTUAL RATE	95% CONFIDENCE INTERVAL
1970	.00051	.00065	(.00039, .00066)
1971	.00048	.00054	(.00037, .00063)
1972	.00046	.00041	(.00035, .00060)
1973	.00043	.00035	(.00033, .00057)

This truism is confirmed by the plot of average productivity per man in Figure IV-4. The output per man day was trending upwards almost in a straight line until 1969. After 1969, it fell dramatically.[24] This result was confirmed by regression analysis.

A regression of output per man day on a time trend and a dummy variable for the legislation gave the equation,

$$(4\text{-}6) \qquad OPD = \underset{(18.15)}{6.63} + \underset{(15.31)}{.54\ TIME} - \underset{(-8.94)}{4.91\ D70}$$

$$R^2 = .93$$
$$DW = 1.42$$
$$N = 21,$$

where OPD is output in tons per man day, TIME is a linear time trend, and D70 is a dummy which equals 0 from 1953 to 1969 and equals 1 from 1970 to 1973. The t-statistics are in parentheses. Clearly, the Act had a significant effect on output per man day. An alternative method was tried to test for the same result. An equation was fit to the period from 1953 to 1969 with output per man day as the dependent variable and time as the independent variable. This equation was then used to predict the output per man day for the years 1970 to 1973 and the predicted and actual values were then compared. The predicted values were significantly greater than the actual values, as one would expect on the basis of equation (4-6), with the difference between the predicted and actual values growing over the period from 1970 to 1973. However, the Durbin-Watson statistic was only .49. This suggested a high degree of autocorrelation with consequent overstating of significance. Therefore the equation and the predicted and the actual

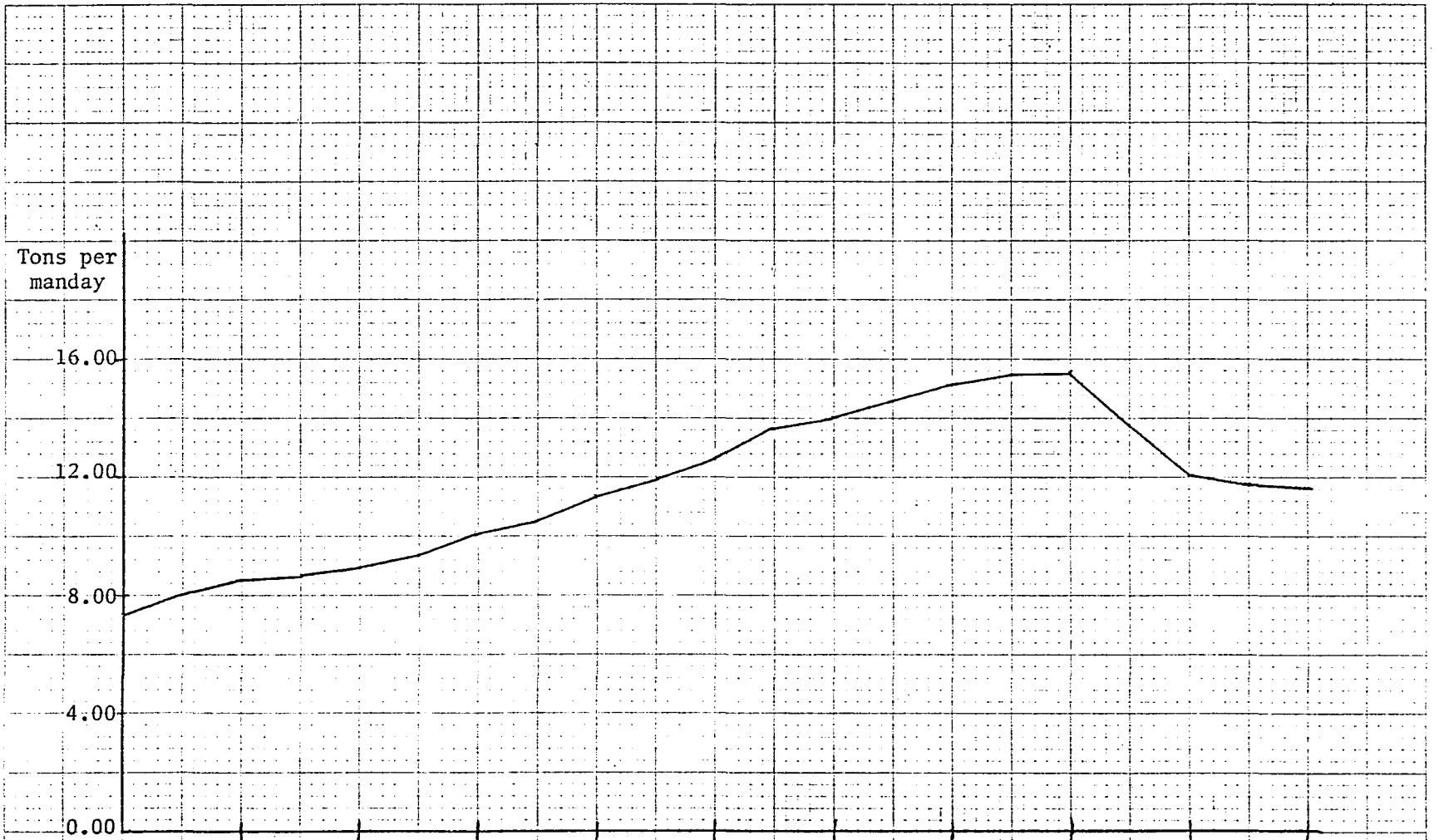

FIGURE IV-4: Tons of bituminous coal per manday in underground mines, 1953-1973.

values are not reported. Instead the first difference of output per man day was regressed on D70, the dummy variable. The resulting equation was,

$$(4\text{-}7) \qquad \underset{}{\text{OPDFD}} = \underset{(4.74)}{.51} \; \underset{(-6.23)}{-\,1.50\ \text{D70}}$$

$$R^2 = .68$$
$$DW = 1.20$$
$$N = 20,$$

where OPDFD is the first difference of output per man day. The t-statistics are in parentheses. Clearly, the 1969 Act had a significant effect. The conclusion that the Act had a significant negative impact on output per man day is robust.

Some Costs and Benefits of the 1966 Act

The 1966 Act appeared to have a small effect on injuries in mines of size one to nine men.[25] As can be seen from Table IV-1, equations (4-1) and (4-3) overpredict the number of fatalities and non-fatal injuries by approximately 100 percent.[26] Approximately 20 fatal and 400 non-fatal injuries annually were prevented in mines of size one to nine men by the 1966 Act. What was the value of these benefits?

To answer this, I used the estimate of the value of a "life" generated by Thaler and Rosen.[27] Thaler and Rosen regressed wages against the risk of death across industries in order to answer the question, "How much would 100 average workers be willing to pay to avoid a .01 probability of death?" However, the number which they estimated is not an answer to this question. Since the risk of death is highly correlated with the risk of a non-fatal injury across

industries,[28] their estimate was really an estimate of the value of avoiding a package of deaths and non-fatal injuries. This estimate is entirely appropriate for my purposes. The value they estimated for the value of a "statistical" life was $176,000 in 1967 dollars. Of course, this is really an estimate of the value of avoiding a death plus a number of non-fatal injuries equal to the ratio of non-fatal injuries to fatalities.

Since the percent of injuries resulting in fatalities was higher in coal mining than in the other industries in the Thaler-Rosen sample,[29] the coal mining industry would appear, just on the basis of the fatality rate, to be riskier vis-a-vis the other industries than it really was.[30]

As can be seen from Table IV-1, the percent of injuries resulting in deaths in mines of size one to nine men (approximately five percent) was even greater than in bituminous coal mining in general (2.3 percent). That is, the number of non-fatal injuries associated with a fatal injury in mines of size one to nine men was approximately one fifteenth of the average number in the Thaler-Rosen sample. This means that the number of non-fatal injuries in the Thaler-Rosen "package" of one fatality and some non-fatality injuries is higher than the number of non-fatal injuries associated with a fatality in coal mining. Therefore, their estimate of the value of the package is an <u>overestimate</u> of the value of injury avoidance in coal mining.

Therefore, an upper bound can be placed on the value of injuries saved by the 1966 Act. This bound equals 20 (the number of fatalities saved) times $176,000, or 3.5 million in 1967 dollars.[31]

The costs of the 1966 Act are more difficult to estimate. As was shown, the 1966 Act resulted in a drastic reduction in the number and output of small mines. This suggests that small coal mine owners and workers suffered losses on specific non-human and human capital invested in coal mining. Given that approximately 2500 small mines left the industry in response to the 1966 Act,[32] the rent loss would have had to be only $1400 per mine per year to outweigh the gain in injuries avoided. This seems to be a small number. Moreover, there were costs associated with the Act such as the cost of enforcement and the cost of debating and passing the legislation. Although one cannot conclude with certainty, it is a good bet that the costs of the 1966 Act outweighed the benefits.

Some Costs and Benefits of the 1969 Act

Not all of the costs and benefits of the 1969 Act can be calculated. This should not deter us from looking at those that can be calculated. What follows therefore is an incomplete, but not for that reason useless, cost-benefit analysis of the Act.

Benefits

The potential benefits of the 1969 Act would fall under three categories: (1) fewer fatalities, (2) fewer non-fatal injuries, and (3) a lower incidence of black lung disease.

The Act did not result in fewer fatalities. As for non-fatal injuries, since the federal government changed its standard for a non-fatal injury, the effect of the Act on the number of non-fatal injuries cannot be known. However, ex ante one should be skeptical

about the possibility that the Act reduced non-fatal injuries, given the high correlation between fatal and non-fatal injury rates. Finally, since black lung disease is a phenomenon which develops over a long exposure to coal dust, the Act has not been in effect long enough to gauge its effect on black lung. Therefore, a final tally of the benefits cannot be made.

Costs

The potential costs of the Act came under six[33] categories: (1) the increase in expenditure on capital equipment, (2) the cost of workers' time devoted to compliance, (3) the lawyers' fees paid by coal companies to lower their fines, (4) the consumer surplus triangle loss from the output foregone due to the higher price of coal which is due in turn to factors (1), (2), and (3), (5) the loss in rents to specific capital (human and non-human) in coal mining, and (6) the cost of paying inspectors.

Some of these costs are illustrated in Figure IV-5. This figure is drawn on the assumption that the cost curve in bituminous coal mining is horizontal.[34] Therefore cost (4), the lost rents to specific factors, cannot be represented. However, even though the cost curve in coal mining is horizontal in the long-run, in the short-run it must be upward-sloping. In that case, there would be rents lost due to the legislation. The shaded area in Figure IV-5 represents costs (1), (2), and (3). The triangle represents cost (4). Cost (6) is not shown in the diagram since this cost is borne by taxpayers rather than by economic actors in their role as consumers and producers of coal.

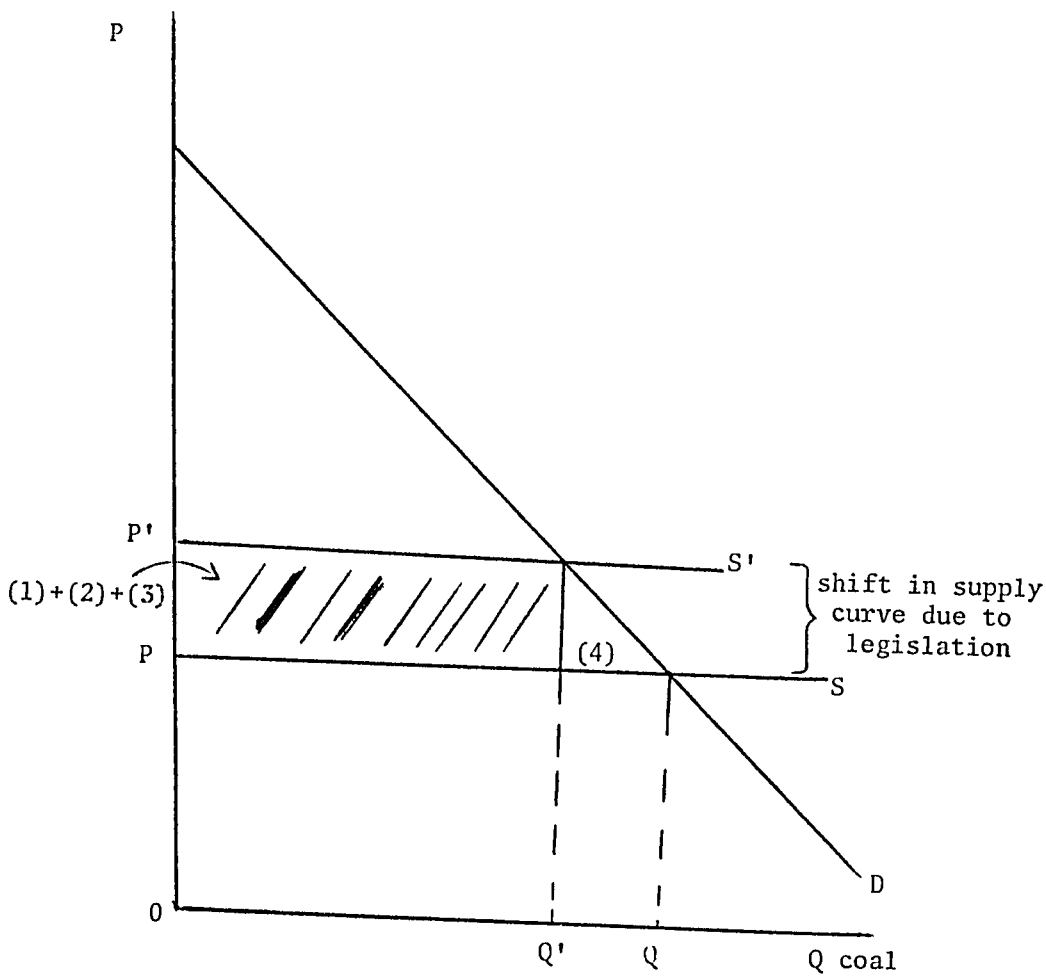

FIGURE IV-5: Graphical representation of some of the welfare costs of the legislation.

Since there are no good data on capital expenditures on safety equipment in underground bituminous coal mines, there are obviously no good data on changes in such capital expenditures. Therefore cost (1) cannot be calculated.

A good idea can be gotten about cost (2). The fall in output per man day can be used to calculate the increase in the labor cost per ton of coal caused by the 1969 Act. The number of manhours required per ton of coal produced was calculated for 1969, the last year before the Act, and for 1973, the last year for which data exist. The difference between the former and the latter was then calculated. Since the average product of labor was trending upward before the Act and probably would have continued trending upward in the absence of the Act, this difference would be an underestimate of the increase in labor per ton required by the Act. This number equals .18 hours per ton. To calculate the labor cost in dollar terms, one must choose a wage rate.

Assuming a growth rate of the real wage of laborers equal to 2 percent per year, the 1973 average wage, given that the 1969 average wage was $3.83[35] per man hour would have been $4.15 per man hour (all in 1967 dollars). From this should be subtracted the risk premium saved due to the fact that the fatality rate per man hour fell significantly. Thaler and Rosen[36] estimate the value of a .001 decrease in the probability of death at $.08 per hour. Since, in 1973, the probability of death was .0006 lower than predicted,[37] the wage should have fallen by approximately $.05 per hour.[38] Therefore a conservative estimate of the appropriate wage used for valuing the cost of labor

devoted to compliance would be $4.10 per man hour.[39] Thus a conservative estimate of the increase in the social cost of labor per ton of coal mined in 1973 due to the 1969 Act would be the .18 manhours increase per ton times $4.10 per manhour, or $.74 per ton. Assuming that the .18 manhours estimate is a conservative estimate of the drop of labor productivity due to the Act, the 1976 cost, again assuming a 2 percent growth rate of the real wage, would be .18 times $4.35 per hour, or $.78 per ton. In 1976 dollars this equals $1.34 per ton. Assuming an underground output of 300 million tons of bituminous coal in 1976, the increase in the social cost of labor due to the 1969 Act is $402 million.

This estimate of the increase in the labor cost of coal is somewhat lower than the estimate made by John Straton[40] of the increase in the cost of mining per ton from 1969 to 1974. Straton distributed confidential questionnaires to 140 relatively large mines and asked them to calculate their cost increases which they attributed to the Act for every year from 1969 to 1974. The results for the cost increase from 1969 to 1973 ranged from approximately $2.00 per ton to $3.50 per ton. Although the standard caveats should be following in looking at data obtained by questionnaire, these estimates are consistent with mine. The companies calculated their change in cost due to compliance. This change in cost would include the capital cost of compliance. My lower estimate of only $1.34 is just of the labor cost of compliance. Note that Straton's estimates of the cost explain a large part of the increase in the nominal price of underground coal. The nominal price of underground coal rose from $5.62 in 1969 to $10.84 in 1973.

What was the consumer surplus loss due to the lower amount of coal demanded in response to the price increase caused by the Act? To do this calculation requires that one know the fraction of the price increase which was due to the 1969 Act. Now the appropriate measure of the labor cost increase is one which uses the actual real wage. The reason is that there is good reason to believe that the larger than 2 percent growth in real wages between 1969 and 1973 can be attributed to the Act's strengthening of the United Mine Workers.[41] Since the real wage in 1973 was actually $4.31 (in 1967 dollars), the direct labor cost increase per ton was .18 times $4.31, or $.78. There was an indirect labor cost increase which can be attributed to the Act for the same reason that the real wage increase can be attributed to the Act. This cost increase came in the form of an increase in the royalty per ton of coal which the operators of UMW-unionized mines had to pay into the UMW Welfare and Retirement Fund at $.40 per ton. After having been constant from 1952 to 1971, the amount was raised in November 1971[42] to $.60 per ton for coal mined between November 1971 and November 1972, from $.60 to $.65 per ton for coal mines between November 1972 and May 1973, from $.65 per ton to $.70 per ton for coal mined between May 1973 and November 1973, from $.70 per ton to $.75 per ton for coal mined between November 1973 and May 1974, and from $.75 per ton to $.80 per ton for coal mined from May 1974 to November 1974.[43] Since the whole of the royalty increase was negotiated before the OPEC countries increased the price of oil, we can assume that the royalty increase was not due to the oil price increase but instead was due to the strengthening of the union by the 1969 Act. The average royalty

in 1973 was approximately $.675. The royalties must be weighted by the percent of coal produced by UMW-organized mines to get the part of the price increase which can be attributed to the royalty increase. In 1967, the percent of UMW production in underground mines was approximately 80 percent.[44] That percent would be higher in 1973 due to the strengthening of the union. Therefore, a conservative estimate of the royalty increase which can be attributed to the Act would be .80 times (.675 - $.40), or $.22. Therefore, the labor cost of the 1969 Act in 1967 dollars was the sum of the direct labor cost and the indirect labor cost ($.78 plus $.22), or $1.00 per ton. In 1976 dollars, this cost would be $1.36 per ton.

Now, given the elasticity of demand for coal, -.66,[45] and the present price of coal (between $13.00 and $17.00), and assuming a present underground output of 300 million tons in 1976, one can calculate cost (4), the consumer surplus triangle loss from foregone output. A sample calculation is presented to show the method used. Assume that the price of coal is $13.60. Then the $1.36 increase due to the 1969 Act represents 10 percent of the present price. In the absence of the legislation, the price would be 10 percent lower and, with the elasticity of demand equal to -.66, output would be 6.6 percent, or approximately 20 million tons, higher. Therefore, the triangle loss is approximately 1/2 × 20 million × $1.36, or $13.6 million. Assuming a present price of $17.00, the triangle loss is approximately $10 million.

Witt, Palomba and Palomba[46] conservatively estimated cost (6), the cost of hiring inspectors at $11.3 million in 1972. Updating the

wage levels to 1976, the cost of inspectors would be approximately $15 million.

Finally, the cost of hiring lawyers to fight off fines is a relevant cost of the legislation. According to a report in the United Mine Workers Journal,[47] MESA settled for collecting approximately $7 million of the $44.4 million of fines assessed from 1970 until May 31, 1974. This means that the coal company lawyers managed to cut the fines by $37.4 million over a three year period. Certainly one would expect that this $37.4 million would be an upper limit on the payments made to lawyers. In fact, the payments would probably be significantly below this amount. If the lawyers' fees were 25 percent of the amount saved, then the annual cost of lawyers attributable to the legislation is approximately only $3 million.

The sum of all the costs that have been calculated--the cost of labor devoted to compliance, the consumer surplus triangle loss, the cost of hiring inspectors, and the cost of lawyers is $434 million annually. This is an underestimate since the capital cost of complying with the Act has not been calculated. Clearly, the main component of the cost is the labor cost of complying. The estimates of the consumer surplus triangle loss and of the cost of lawyers are admittedly crude, but their order of magnitude is such that more careful estimation of them would not change the total cost estimate significantly.

Given that the 1969 Act did not significantly reduce fatalities, one is hard put to understand its proponents claims' for it at the 1969 Hearings. Also, given that fatalities per manhour fell, it is

difficult to understand why the wage did not fall. Is there an answer to these puzzles? We turn to some answers in Chapter V.

FOOTNOTES

1. See U.S., Congress, Senate, Committee on Labor and Public Welfare, Amendments to the Federal Coal Mine Safety Act, Hearings before the Subcommittee on Labor on S. 1032 and H.R. 3584, 89th Cong., 1st sess., 1965.

2. See Hearings referenced in footnote 1.

3. For the complete Act, see Pub. L. 89-376 (March 26, 1966), Federal Coal Mine Safety Act Amendments of 1965. 80 Stat. 84.

4. Tom S. Witt, Catherine A. Palomba, and Neil A. Palomba, "Some Economic Factors Affecting Safety in Underground Bituminous Coal Mines: Comment," Southern Economic Journal 42 (October 1975): 306-308.

5. They did likewise for the 1969 Act but had only one observation after the passage of the Act.

6. I discovered this late in the dissertation stage. Most of the specifics of the Act relate to underground coal mines. I have restricted my discussion to the latter. I have narrowed it down even more than that. I shall look only at bituminous coal mines, since Pennsylvania anthracite mines were brought under more stringent state regulation in 1965 and it would be almost impossible to separate the effects of state and federal regulation.

7. The Act was considered and passed by the House on October 29, 1969 and December 17, 1969 respectively, and considered and passed by the Senate on October 2, 1969 and December 18, 1969 respectively. It was signed into law on December 30, 1969. For the complete Act, see Pub. L. 91-173 (December 30, 1969), Federal Coal Mine Health and Safety Act of 1969. 83 Stat. 742.

8. See U.S., Congress, House, Committee on Education and Labor, Coal Mine Health and Safety, Hearings before the General Subcommittee on Labor on H.R. 4047, H.R. 4295, and H.R. 7976, 91st Cong., 1st sess., 1969.

9. I have done no analysis of the effect of this subsidy. The subsidy was almost entirely a pure transfer with no allocative effects, since it would be difficult to develop a bad case of black lung in time to collect the payments.

10. See U.S., Congress, House, Committee on Education and Labor, Coal Mine Health and Safety, Hearings before the General Subcommittee on Labor on H.R. 4047, H.R. 4295, and H.R. 7976, 91st Cong., 1st sess., 1969, p. 62.

11. See U.S., Congress, Senate, Committee on Labor and Public Welfare, Coal Mine Health and Safety, Hearings before the Subcommittee on Labor on S. 355 and similar bills, 91st Cong., 1st sess., p. 1732.

12. U.S., Congress, Senate, Federal Coal Mine Health and Safety Act, S. Rept. 411, 91st Cong., 1st sess., 1969, p. 29.

13. This number was obtained by multiplying the number of manhours spent underground in bituminous coal mines from 1952 to 1969 (approximately 3 billion) by the percent of output mined in non-gassy mines in 1968 (39 percent), which is taken as a representative year.

14. See U.S., Congress, House, Committee on Education and Labor, Prevention of Major Disasters in Coal Mines, Hearings on H.R. 7408, 82d Cong., 2d sess., 1952, p. 134.

15. See footnote 13 for the date used for this calculation.

16. Many of the state reports from which the data were culled did not specify whether the numbers were for workers employed underground or for both underground and above ground workers.

17. The effect of the 1969 Act on the output share of small mines in the one to nine man size category cannot be gauged since the series used to determine the effect of the 1966 Act ended in 1970.

18. As was noted, this was not found to be the case.

19. The cost of enforcement is probably not very high. Most wage and hour legislation is enforced by workers. Workers who work over the legal amount of time or get paid under the legal wage can go to the government and have the employer forced to pay overtime or the difference between the actual and the legal wage for all past hours worked. This effectively prevents the employer and employee from cheating. Note the implication of this fact for illegal aliens who dare not report the employer to the government. The minimum wage is probably a boon to illegal aliens since it prices out their legal competition without pricing out the aliens.

20. Jon P. Nelson and George R. Neumann, "The Effect of the Coal Mine Health and Safety Act of 1969 on Labor Productivity and Accidents," (unpublished, Pennsylvania State University, 1976).

21. The number of days lost by a worker before an injury was required to be reported was lowered. See U.S., Department of the Interior, Bureau of Mines, Mineral Industry Surveys, Coal Mine Injuries and Worktime, June 1972.

22. Formerly the Bureau of Mines.

23. The other study, by Tom S. Witt, Catherine A. Palomba, and Neil A. Palomba, "Human Capital Losses and Federal Safety Legislation in Bituminous Coal Mining," (unpublished, University of West Virginia, 1974), is subject to the same criticism as the Nelson and Neumann paper.

24. Data are not yet available for the years since 1973.

25. The non-existence of data on mines with 10 to 14 workers during the relevant period prevented the estimation of the effect of the 1966 Act on these mines.

26. Although only in the case of non-fatal injuries was the predicted value significantly higher than the actual at the 95 percent confidence interval.

27. Richard H. Thaler and Sherwin Rosen, "The Value of Saving a Life: Evidence from the Labor Market," in Household Production and Consumption, ed. Nestor TerLeckyj (New York: National Bureau of Economic Research, 1975), p. 292.

28. Thaler reports that the correlation coefficient between fatal and non-fatal injury rates across BLS (Bureau of Labor Statistics) defined industries during this period was .81.

29. In 1967, a normal year, 2.3 percent of the injuries in bituminous coal mining resulted in death while the unweighted average across industries in the Thaler-Rosen sample was .34 percent. No industry in their sample had as high a percent as bituminous coal mining.

30. This is because for every fatality in the coal mining industry, there were fewer non-fatal injuries.

31. This estimate of benefits excludes the benefits from increased safety in mines with 10 to 14 workers.

32. See Table IV-4.

33. A seventh category of costs would be the fines levied and collected by the Bureau of Mines for non-compliance with the Act. Whether one regards these as costs, however, depends on how one values the increased output of government financed by these fines. It is difficult to evaluate most types of government output. It is well-nigh impossible to detect which types of government output were increased by the fines.

34. Evidence supporting this assumption is presented in Morris Goldstein and Robert S. Smith, "The Predicted Impact of Black Lung Benefits Program on the Coal Industry," Technical Analysis Paper No. 14, Office of the Assistant Secretary for Policy, Evaluation and Research, Department of Labor, December 1973 and

34. (contd.) in G.S. Maddala, "Productivity and Technological Change in the Bituminous Coal Industry," Journal of Political Economy 73 (August 1965): 352-365.

35. All wage data are taken from U.S., Department of Labor, Bureau of Labor Statistics, Employment and Earnings, various issues.

36. Thaler and Rosen, "Value of Saving a Life," p. 292.

37. See Table IV-6.

38. The wage should have fallen by less than $.05 per hour due to the fact that the mix of fatal and non-fatal injuries in coal mining is different from the mix in other industries.

39. In fact, the average real wage in 1973 in bituminous coal mining was $4.31, somewhat higher than the $4.10 predicted here. This suggests that laborers earned rents as a result of the 1969 Act. This issue will be discussed further in Chapter V. Since we are trying to calculate the social cost of the legislation, it is inappropriate to use the actual increase in labor cost per ton, since a component of the increase is rent to laborers.

40. See John Straton, "1970-74 - A Period of Adverse Changes in Productivity and Costs at Underground Bituminous Coal Mines," Mining Congress Journal (October 1975). For a similar study see John Straton, "Effects of Federal Mine Safety Legislation on Production, Productivity and Costs," Mining Congress Journal (July 1972): 19-23.

41. See Chapter V.

42. The contract between the United Mine Workers and the Bituminous Coal Operators Association is negotiated in November of every third year.

43. See the "National Bituminous Coal Wage Agreement of 1971."

44. See U.S., Department of Labor, Bureau of Labor Statistics, Industry Wage Survey: Bituminous Coal Mining, 1968, p. 3.

45. For this estimate, see Goldstein and Smith, "Black Lung Benefits."

46. See Witt, Palomba, and Palomba, "Human Capital Losses."

47. United Mine Workers Journal, 1-15, July 1974.

CHAPTER V

CUI BONO? THE MOTIVATION FOR THE SAFETY LEGISLATION

> Further, it (the UMW) acts upon the view that the existence of marginal operators who cannot afford these high wages, fringe benefits, and good working conditions does not serve the best interests of the working miner.
>
> --Mr. Justice Arthur Goldberg, United Mine Workers of America v. Pennington (Phillips Brothers Coal Company), 85 S. Ct. 1585 (1965), dissenting opinion, p. 2.

> "...we are going to have safety one way or the other, and we are going to have these high wages, if they call them high wages, to go along with it. They are going to have both."
>
> --W.A. (Tony) Boyle, in Coal Mine Health and Safety, Hearings before the House Committee on Education and Labor, 91st Cong., 1st sess., 1969, p. 235.

Chapter II dealt with the justification of safety legislation in coal mines from the viewpoint of efficiency. It was concluded that the case for safety legislation, especially in the form actually passed, was rather weak. However, even if the case for safety legislation were stronger, the separate question of the motivation for the legislation would still remain. Even if safety legislation improved efficiency, one would still want to understand the motivation of the proponents. It is a safe assumption that whatever the effects of the legislation, economic efficiency per se was not a major goal of any of the participants.

Throughout this discussion use will be made of the idea that large mines are generally UMW-unionized mines and small mines are generally non-union mines. Therefore some theoretical and empirical

justification should be given for this claim.

The theoretical justification is straightforward. Consider how the costs and benefits to the United Mine Workers of unionizing a mine vary with the size of the labor force in the mine (and therefore the size of the mine). One would expect the cost of organizing a mine to be roughly constant or only slightly increasing with the size of the labor force. The gains, however, in the form of restriction of competition, would be roughly proportional to the size of the labor force. Therefore, at a given cost of organizing, one would expect the larger mines to be organized by the UMW more frequently than the smaller mines. There would be an optimal size of mine below which it would not pay to unionize.

The empirical evidence, although somewhat scattered, is supportive of the theoretical proposition. Testimony on various coal mine safety bills through the 1950's and 1960's reveals that most of the small mine operators who opposed the legislation employed non-union labor while all the large mine operators who testified in favor of the legislation employed UMW-unionized labor.[1] Moreover, it was pointed out repeatedly in the Hearings referenced in footnote 1 that many of the small mines were family enterprises owned and manned by members of the same family. One would be surprised to learn that such mines were unionized. Even if the cost of organizing were zero, a family mine would not be unionized since the family owners and laborers could outvote the hired worker(s). In the limit an organization owned and manned solely by a family would have no incentive to unionize since the "exploiter" from the unionization would be the same economic unit as

the "exploited." The move to unionization would be at best a zero-sum game with one economic unit receiving the sum. The family-run enterprise would have no good reason to accept voluntarily an added constraint imposed from "outside." Union rules, union royalties, and union wages would constitute such a constraint.

The final and most convincing piece of evidence is from a wage survey done by the Department of Labor. This survey found[2] that in 1967 almost 100 percent of workers in underground mines with 50 or more workers were in the United Mine Workers, while only 33 percent of workers in mines with 10 to 49 workers were members of the United Mine Workers.

The Political Support for the 1966 and 1969 Legislation

The 1966 and 1969 Acts were lobbied for by the Bureau of Mines, the UMW, and large coal miners.[3] Small non-union coal miners lobbied against the 1966 and 1969 Acts. Although there were no non-union employees' representatives who testified, the President of the Southern Labor Union, a weaker union than the United Mine Workers, did testify in 1965.[4] He did not oppose the bill but did try to introduce amendments to assure arms' length dealings between the Bureau of Mines and the United Mine Workers. He expressed fear that the Bureau of Mines would discriminate against mines unionized by competitive unions (the Southern Labor Unions and the Progressive Mine Workers of America which together had unionized only three percent of the workers)[5] and non-union mines. He also stated that small mine operators and employees opposed passage of the bill.

The Militant Workers Hypothesis

According to the militant workers hypothesis[6] (MWP), the rank-and-file were being sold out by Tony Boyle. Boyle was too close to the coal mine operators,[7] and too concerned about his own welfare so the hypothesis goes, to be concerned about the interests of the workers. Therefore the workers were receiving a lower total (pecuniary and safety) wage package than otherwise, with the mine operators and Boyle sharing the difference. Note, parenthetically, that this argument has no implication that the amount of safety was below the optimum. Boyle was an autocratic union leader and used the union's finances for his own ends.[8] One would be very surprised if he had not done so given the autocratic union structure set up by John L. Lewis.[9] However, as was pointed out in Chapter II, there would be gains to Boyle from assuring that the workers received the optimal amount of safety given their low total wage package.

Since, by the MWP, the workers were not doing as well as they could do, they lobbied for the safety legislation. But why would they lobby for safety legislation? If they gained the safety legislation, and the safety legislation did in fact produce safety, wouldn't the wage drop to compensate for the increase in safety? Would not a preferred alternative be to elect a leader who would push for a higher wage-safety package at the bargaining table? The answer could be that since the contract was a three-year contract, the workers' wage would not fall with the increase in safety until the contract came up for renewal. By that time, possibly, the workers would have deposed Boyle, and replaced him with Jock Yablonski.

However, the hypothesis that the safety legislation was an attempt by the UMW workers to wring a higher total wage package out of Boyle and the coal mine operators has two predictions which are not borne out. One would expect, according to this hypothesis, that Boyle would lobby against the legislation. He did not lobby against it although it is unclear whether he lobbied for it. He certainly appeared to lobby for it in the minutes of the Hearings on the legislation.[10] However, according to Senator Harrison Williams, Chairman of the Subcommittee on Labor, his subcommittee received very little help from Boyle in drafting the 1969 bill. In Williams' words, Boyle "really waltzed that one."[11] Williams claimed that his committee had to fight Boyle at every turn.

The other prediction of the MWP is that large coal mine operators should oppose the legislation. On the contrary, as was pointed out,[12] whenever they took a position on the legislation, they embraced it. However, it could be argued by proponents of the MWP that passage was a foregone conclusion and that therefore they supported it in order to get some of the content watered down.

One final implication of the MWP is that since firms would suffer a wealth loss from this legislation, the stock prices of the firms should fall on introduction of the legislation, should fall again on passage of the legislation, and should fall further on the signing of the legislation into law.

To test the possibility, I used New York Stock Exchange data on the CRSP (Center for Research in Securities Prices) tape to fit the returns[13] of coal companies on the market portfolio.[14] The resulting equations were used to predict the returns in the subsequent periods during which

the legislation was being introduced, debated and passed. The residuals, that is, the difference between the predicted and actual values, were calculated for this period. The four companies whose stocks were listed on the NYSE during the relevant period were Mountain Fuel Supply Company, North American Coal Corporation, Peabody Coal Company, and Pittston Company. Since Peabody was merged with Kenneott Copper in October 1968, it was dropped from the sample after the somewhat arbitrarily chosen date of December 1966 on the grounds that the anticipation of the merger would have some effect on the Peabody stock price before the merger actually occurred. The four equations were:

(5-1) $R_{MFS}(t) = .0056 + .72\ R_M(t)$, for Mountain Fuel Supply Company,

(5-2) $R_{NA}(t) = -.015 + 1.52\ R_M(t)$, for North American Fuel Company,

(5-3) $R_{PDY}(t) = .0079 + 1.02\ R_M(t)$, for Peabody Coal Company,

(5-4) $R_{PCO}(t) = .00077 + 1.37\ R_M(t)$, for Pittston Company,

where $R_M(t)$ is the return on the market (i.e., NYSE) portfolio at time t. The average residuals and cumulative average residuals (CAR) are presented in Table V-1. As can be seen, the returns on the four stocks fell relative to the predicted value during the period of introduction and passage of legislation by an average of 37 percent (= CAR Mar. 1966 − CAR Jan. 1965). This result is strange, even from the viewpoint of the MWP. Since small and non-union mines were the main mines affected by the 1966 legislation, it is difficult to see how large mining companies would be adversely affected by it.

TABLE V-1: Average Residuals and Cumulative Average Residuals of Returns on Coal Company Stocks, January 1964 to December 1971.

MONTH		AVERAGE RESIDUAL	CAR	NUMBER OF FIRMS
Jan. 1964	1.	.044	.044	4
	2.	.014	.058	
	3.	-.080	-.023	
	4.	-.022	-.044	
	5.	.010	-.034	
	6.	-.054	-.088	
	7.	.016	-.072	
	8.	-.034	-.106	
	9.	-.027	-.134	
	10.	-.009	-.143	
	11.	.018	-.125	
	12.	-.009	-.134	
Jan. 1965 Intro. of 1966 Bill	1.	.036	-.099	
	2.	-.043	-.142	
	3.	-.009	-.150	
	4.	-.047	-.197	
	5.	.001	-.197	
House Passage	6.	.013	-.184	
	7.	-.039	-.223	
	8.	-.035	-.258	
	9.	-.052	-.310	
	10.	-.052	-.310	

TABLE V-1 (contd.)

MONTH		AVERAGE RESIDUAL	CAR	NUMBER OF FIRMS
	11.	.012	-.281	
	12.	-.029	-.310	
Jan. 1966	1.	-.047	-.358	
	2.	-.005	-.363	
Senate Passage, Signing	3.	-.003	-.366	
	4.	-.017	-.383	
	5.	.006	-.377	
	6.	-.038	-.415	
	7.	.046	-.369	
	8.	.071	-.298	
	9.	.014	-.284	
	10.	.009	-.275	
	11.	-.040	-.314	
	12.	.049	-.266	
Jan. 1967	1.	-.077	-.343	3
	2.	.040	-.303	
	3.	.046	-.258	
	4.	-.011	-.268	
	5.	.085	-.183	
	6.	-.023	-.206	
	7.	-.086	-.292	
	8.	.051	-.241	
	9.	-.025	-.266	

TABLE V-1 (contd.)

MONTH		AVERAGE RESIDUAL	CAR	NUMBER OF FIRMS
	10.	.022	-.244	
	11.	-.042	-.286	
	12.	-.056	-.342	
Jan. 1968	1.	.115	-.228	
	2.	-.039	-.267	
	3.	.021	-.246	
	4.	-.107	-.353	
	5.	.117	-.237	
	6.	-.037	-.273	
	7.	-.002	-.275	
	8.	-.019	-.295	
	9.	-.008	-.302	
	10.	.012	-.291	
Farmington Disaster	11.	-.023	-.313	
	12.	-.011	-.325	
Jan. 1969 Intro. of 1969 Act	1.	-.006	-.331	
	2.	.017	-.314	
	3.	-.048	-.362	
	4.	.037	-.325	
	5.	-.019	-.345	
	6.	.047	-.298	
	7.	.085	-.213	
	8.	-.000	-.213	

TABLE V-1 (contd.)

MONTH		AVERAGE RESIDUAL	CAR	NUMBER OF FIRMS
	9.	.007	-.206	
	10.	.005	-.201	
	11.	.054	-.147	
Passage and Signing	12.	.122	-.026	
Jan. 1970	1.	.064	.039	
	2.	.042	.080	
	3.	-.027	.054	
	4.	.037	.091	
	5.	.134	.225	
	6.	-.018	.207	
	7.	.076	.283	
	8.	-.042	.241	
	9.	.053	.293	
	10.	.103	.397	
	11.	-.003	.394	
	12.	-.004	.390	
Jan. 1971	1.	-.021	.369	
	2.	.002	.371	
	3.	-.015	.356	
	4.	-.067	.289	
	5.	.008	.297	
	6.	.054	.351	

TABLE V-1 (contd.)

MONTH	AVERAGE RESIDUAL	CAR	NUMBER OF FIRMS
7.	-.004	.347	
8.	-.076	.271	
9.	-.024	.247	
10.	.010	.257	
11.	-.033	.224	
12.	.052	.276	3

A possible cause of the lower than predicted returns is that the risk on these stocks fell as a result of the legislation. In that case, one would expect the return to fall. Therefore, I calculated the risk (i.e., the coefficient on the market rate of return variable) during the period from April 1966 to October 1968,[15] that is, for the period after the signing of the 1966 Act but before the anticipation of the 1969 Act. The risk (beta) coefficients for Mountain Fuel Supply Company, North American Coal Company, Peabody Coal Company, and Pittston Company for the later period were .34, .84, -.07, and 1.03 respectively, compared to .72, 1.52, 1.02, and 1.37 for the earlier period before the 1966 Act. That is, for each stock, the risk did drop. A Chou test revealed that only in the case of Peabody was the difference in risk significant. These results remain an enigma, both from the viewpoint of the militant workers hypothesis and from the viewpoint of the barriers to entry hypothesis to be presented later in the Chapter.

As can be seen from Table V-1, the effect of the 1969 Act on the value of the three coal firms is different from the effect of the 1966 Act. From the time of the bill's introduction in January 1969 until its passage and signing into law in December 1969, the returns on the three stocks increased relative to the predicted value by 10 percent. During 1970 the returns rose even more relative to the predicted values. The opposite would have been predicted by the MWP. The beta coefficients for the three stocks were found by a Chou test to be insignificantly different from those in the base period. The beta coefficients for Mountain Fuel Supply Company, North American Coal

Company, and Pittston Company were .45, 1.69, and .97 respectively for the period January 1970 to September 1972, compared to .72, 1.52, and 1.37 for the earlier period. Therefore, the increase in returns cannot be accounted for by an increase in risk.

The Barrier to Entry Hypothesis

Another hypothesis to explain the political support for and opposition to the safety legislation is the barrier to entry hypothesis (BTEH). According to this hypothesis, the large mine companies which owned primarily large, and therefore, unionized mines,[16] and the UMW, supported this legislation in order to wipe out the small non-union mines. Small non-union miners would oppose the legislation in order to prevent being wiped out. For this to happen, the legislation would have to constitute a differential tax on small mines. There are three ways in which the legislation could constitute a differentially large tax on small mines. The legislation would constitute such a tax if there were economies of scale in compliance. It was suggested in Chapter IV that there were indeed economies of scale in complying with certain requirements of the 1969 legislation. Another way is if it imposes requirements on small mines which are already being met by the large mines. The 1966 Act which brought small mines under regulation did this. The elimination of the gassy-non-gassy distinction in the 1969 Act also did this. One final way comes about if the legislation actually does produce safety,[17] and if safety is a normal good. Since union wages were significantly higher than non-union wages before the legislation,[18] then even if safety were increased equally in union and non-union mines, workers in non-union mines would

value the safety less than the workers in the higher-wage union mines, and the wage cut they would be willing to accept to pay for the safety would be lower. This would cause production costs to rise more for small (non-union) than for large (union) mines.

Figure V-1 makes clear the gains to the unionized firms and the union from wiping out the non-union firms. Assume that DD is the demand for underground coal and that union and non-union coal are considered perfect substitutes by buyers. Assume that $\sum MC_{nu}$ and $\sum MC_{u}$ are the horizontally summed cost curves of the non-union and union sector respectively. Then at each price, the demand for union coal, $D_u D_u$, can be calculated by subtracting the quantity of non-union coal supplied (given by the point on $\sum MC_{nu}$ at that price) from DD to get the demand for union coal.[19] The perfectly competitive price would be P_1. It is now clear why unionized firms and the union would want to wipe out non-union mines. In the extreme case in which all non-union mines were wiped out, the demand for union coal would become DD. The new competitive price would be P_2. Assuming that the cost curve is upward-sloping[20] because increasing output requires mine operators to turn to coal which is costlier to mine, there would be rents from the increase in demand to all inframarginal coal producers left in the industry. Moreover, there would be an increase in the derived demand for union labor. Therefore, the union would gain by wiping out non-union producers. Of course, to the extent that non-union operators were earning rents they would be hurt by the legislation and would therefore oppose it, as would non-union workers. So far, the predictions of the positions of various groups on the legislation are

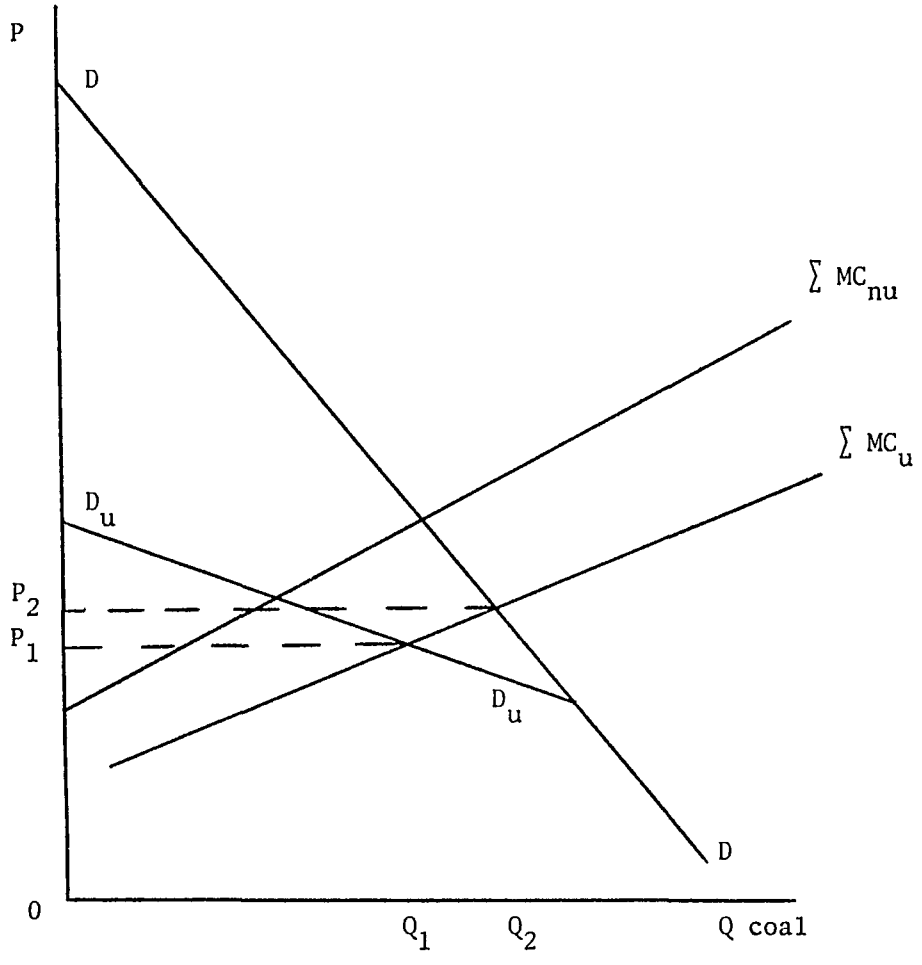

FIGURE V-1: Representation of the equilibrium with and without the non-union sector.

consistent with the facts.

However, this is not the end of the story. Both the UMW and the unionized firms can do better than is implied by the discussion of Figure 5-1. The reason they can do better is that they can use a royalty per ton as a monopolizing device. Before explaining how this could work it is appropriate to give some background and theory of the UMW royalty.

An Aside on the UMW Royalty

Workers in the United Mine Workers union receive their pay in two forms. They receive a wage in the present and an uncertain claim on future pension payments from the United Mine Workers Health and Retirement Fund (formerly the UMW Welfare and Retirement Fund). Payments to the Fund are in the form of royalty payments from operators of unionized mines. The royalty is a fixed nominal amount per ton produced. It is adjusted periodically in the contract between the Bituminous Coal Operators Association (BCOA) and the UMW.[21]

It is clear why the UMW would prefer a royalty per ton to a higher wage rate, since the capital-labor ratio would be affected by the latter but not by the former. That is, the disemployment effect of a royalty would be lower than that of a wage increase designed to return a given income to workers.[22] Another question remains however. Why would the UMW and the BCOA agree to a distorting per ton tax rather than a non-distorting lump-sum tax of the kind imposed by Governor Earl Long on sulfur producers in Louisiana?[23] The answer is that the distortion from a per ton tax is not a distortion that either the UMW or the

unionized mines have an incentive to avoid any more (nor any less[24]) than is the distortion from the withholding of output something that a monopolist has an incentive to avoid. That is, the reason for imposing a royalty per ton is to bring the industry to the monopolistic output. The question to answer is not why the UMW and the unionized mines agreed to a royalty per ton, but rather why other strong unions and unionized firms with a large market share have been so slow to follow.

The answer to this last question could be that individual workers' control over a royalty fund is attenuated. This would explain why the UMW workers have not sought to have the whole of their payment in the form of royalties. But different kinds of royalty funds over which the individual has control can be conceived of. The piece-work system, which existed in coal a century ago,[25] is one example.

However, the problem with such a system is the standard cartel problem. Under a piece-rate system there is an incentive for miners in a given mine, even if unionized, to cheat on the system in one of two ways depending on the strength of the union local. If the local is strong, there is an incentive to cheat by lowering the piece-rate and charging the employer a lump-sum tax to stay in business.[26] If the local is weak, there is an incentive to cheat by simply cutting the piece-rate and/or setting a minimum output since other workers would be willing to work for less than the piece-rate. Therefore, in order to reduce the incentive to cheat by cutting the piece-rate, the industry-wide union must set a royalty which is paid to an industry-wide organization.[27]

The other possible explanation for the non-existence of royalty systems in other industries is that in few industries is the unit on which the royalty could be set as easily defined as in coal mining. Enforcement of the agreement would therefore be more difficult. The issue would repay further study. Possibly there <u>are</u> royalty agreements in other industries.

The above analysis ignores another possible reason for the royalty on union coal as a means of payment.[28] In the right-to-work states - Alabama, Indiana, Tennessee, Utah and Virginia - the royalty could be a disguised way of maintaining a union shop. That is, if an employer signed an agreement with employees who were members of the United Mine Workers, and other employees did not want to join, then, even though they did not have to join, a royalty on the coal they produced would be paid into the UMW Welfare and Retirement Fund. Therefore UMW workers could take a lower hourly wage in return for the higher welfare and retirement benefits. The incentive to stay out of the union would be lower than otherwise. It should be noted that even the hourly wage at union mines was above the hourly wage at non-union mines,[29] and therefore it might still pay to remain outside the union. However, it is still clear that the incentive to remain outside the union would be less than otherwise. This could explain why, in all my institutional reading on the union, I never found a case in which a mine had some workers in the union and others not in the union, even in the right-to-work states. Even though this is a possible reason for the royalty, the first reason given will be used in the subsequent analysis.

The Use of the UMW Royalty to Reach the Dominant Firm Solution

Now we see that the solution depicted in Figure V-1 is not the final solution. Even before the non-union fringe was wiped out, the union and unionized firms would have agreed on a royalty and split the gains from the increase in monopoly profits. Consider Figure V-2 in which the lines are as before but the supply curve for non-union firms is not drawn explicitly. The joint maximum for the unionized firms is given by the output, Q_A, at which $\sum MC_u$ and MR intersect (point A). However, since MR is the marginal revenue curve for the union firms as a whole and not for an individual firm, the industry must impose a ton tax (royalty) to get to Q_A. The royalty is the difference between price and marginal cost or price and marginal revenue at Q_A. This royalty is given by the distance AB in Figure V-2. This is before the non-union firms are eliminated.

Now assume that the non-union firms are eliminated. It can be shown that the interest of the UMW and the BCOA will always be to raise the royalty. There are three possible cases to consider. The proof is as follows.

In case I (see Figure V-3), $\sum MC_u$ intersects MR' (the union firms' marginal revenue curve after the non-union fringe is eliminated) to the left of the intersection with MR (the union firms' marginal revenue curve before the non-union fringe is eliminated). In this case, the profit-maximizing response is to cut output. Since the relevant demand curve is now DD rather than D_uD_u and DD is higher than D_uD_u in the relevant region,[30] and output is lower, the profit maximizing price (not shown) is higher than before. Since this price is

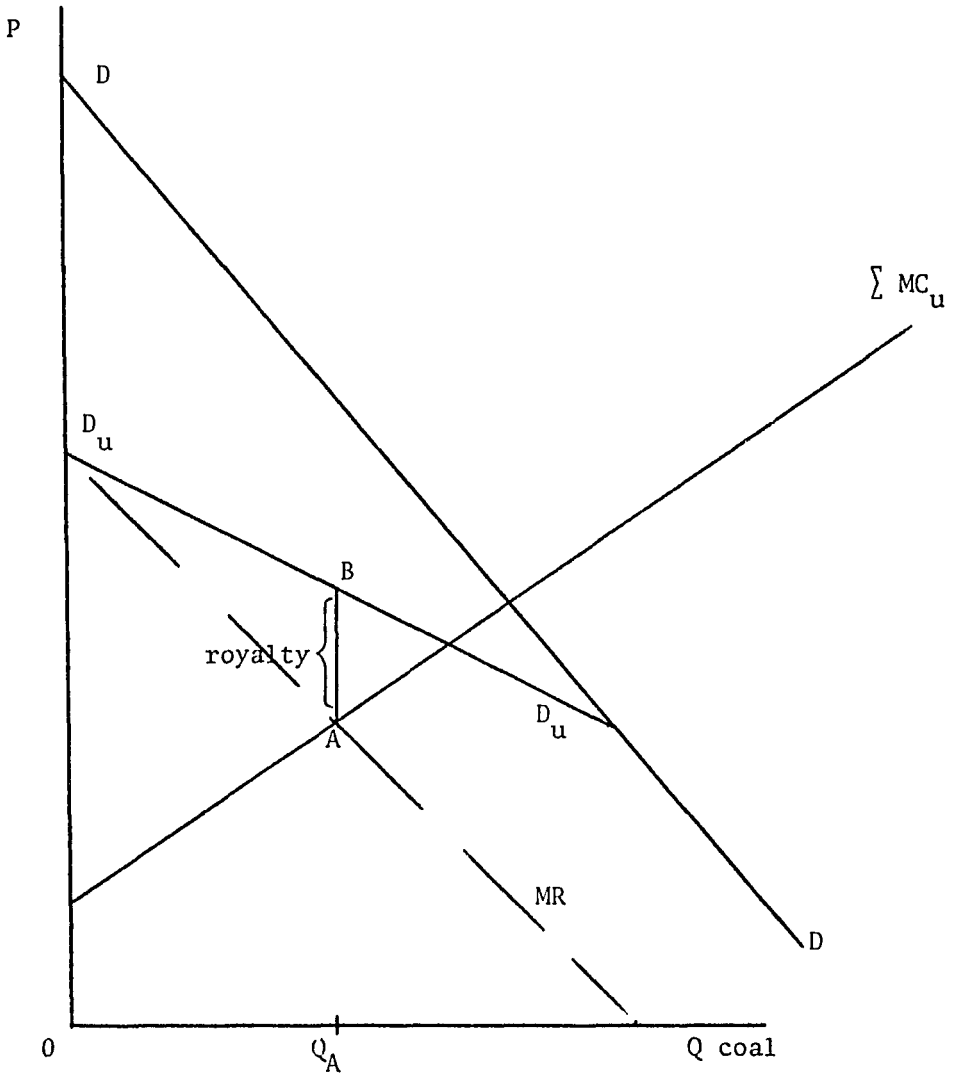

FIGURE V-2: Joint maximum for unionized firms.

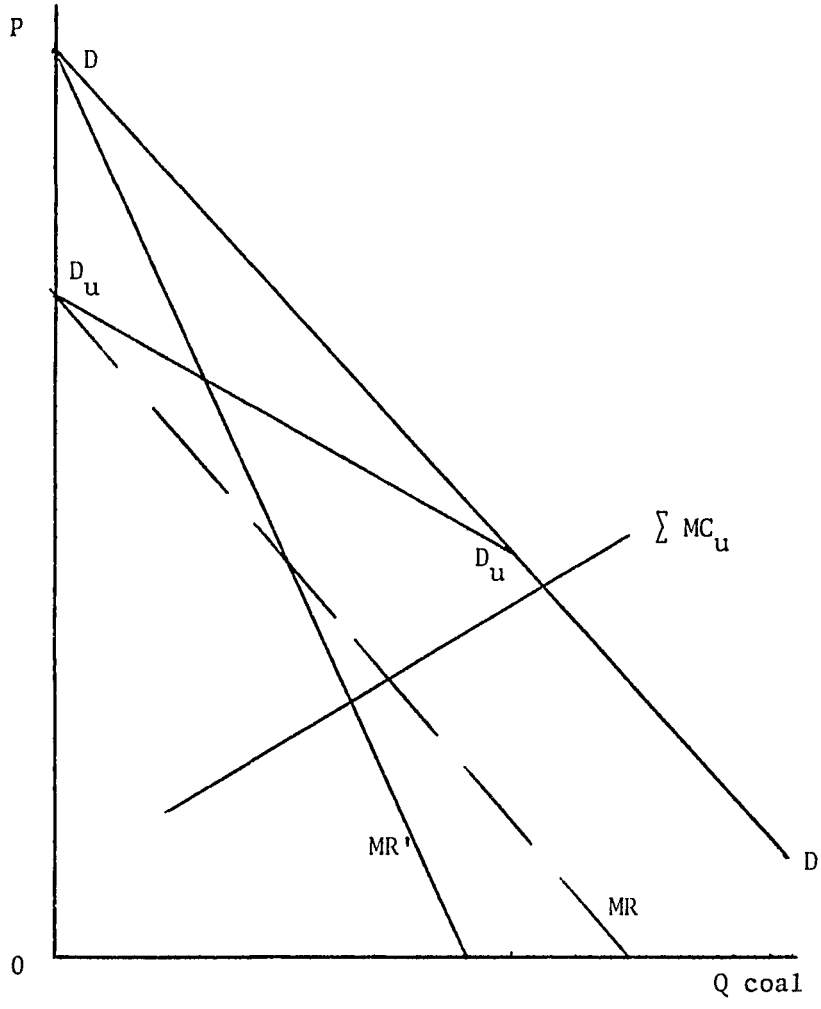

FIGURE V-3: Case in which monopoly output without non-union sector is less than monopoly output with non-union sector.

higher and the marginal cost is lower (since output is lower and the marginal cost curve is upward-sloping),[31] the difference between P and MC at the joint maximum is larger than previously. Since the royalty is set equal to this difference, the royalty is increased. QED.

In case 2 (see Figure V-4), $\sum MC_u$ and MR' intersect at the same point at which $\sum MC_u$ and MR intersect. The proof in this case is trivial. Since in this region DD is above D_uD_u and the output is the same, the new price exceeds the old price. The marginal cost is the same before and after. Therefore, P - MC is larger and the royalty must be increased. QED.

In case 3 (see Figure V-5), $\sum MC_u$ and MR' intersect to the right of the intersection of $\sum MC_u$ and MR. The proof is more difficult. Construct a vertical line from the intersection of $\sum MC_u$ and MR to DD. It intersects D_uD_u at point A and DD at point B. We know that the elasticity of demand at point A, E_A,[32] is greater than the elasticity of demand at point B, E_B.[33] We also know that in general $P - MR = P/E$. Since $P_B > P_A$ and $E_B < E_A$, then $P_B/E_B > P_A/E_A$. Therefore, $P_B - MR_B > P_A - MR_A$. But we know that the output at the new profit maximum is larger than at A and B. As we move down DD, from point B, P - MR increases. Therefore at the new profit-maximizing point on the demand curve, point E, $P_E - MR_E$ is greater than $P_B - MR_B$. Therefore $P_E - MR_E$ is greater than $P_A - MR_A$. The royalty must increase. QED.

Note that the implication that when the non-union firms are wiped out, the BCOA and UMW will raise the royalty is consistent with the facts. That is, after the non-union firms were eliminated, the

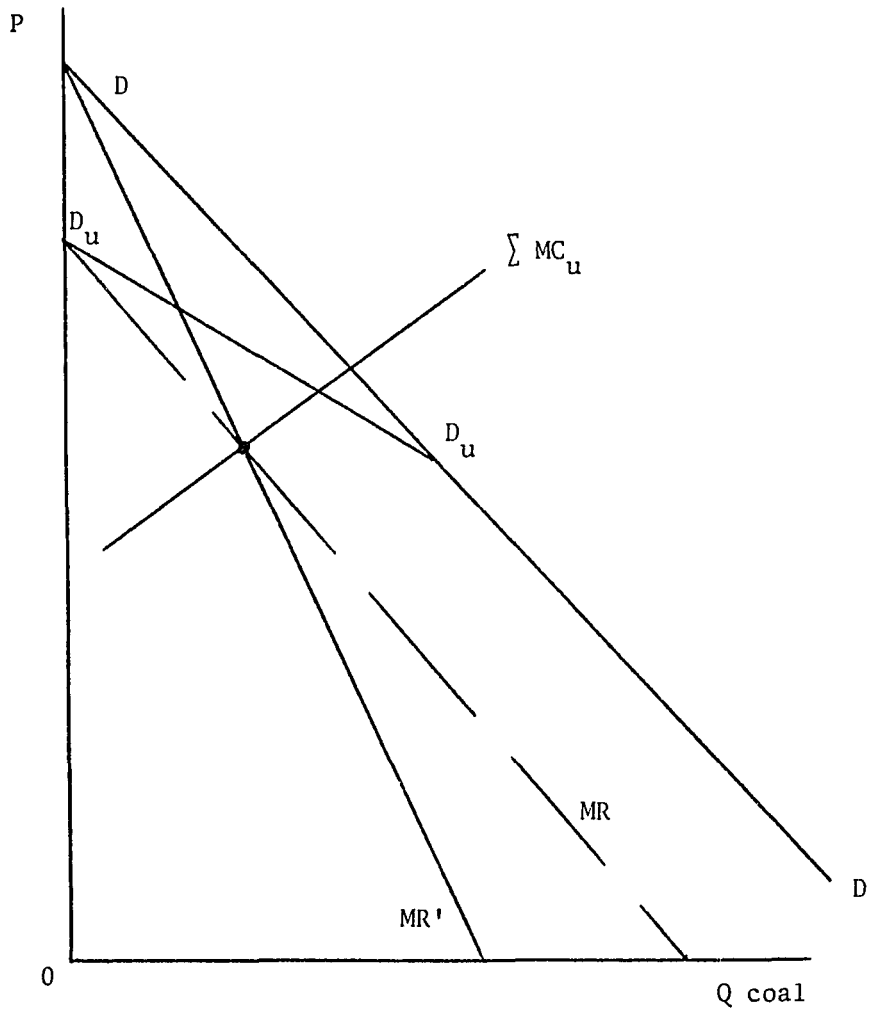

FIGURE V-4: Case in which monopoly outout without non-union sector equals monopoly output with non-union sector.

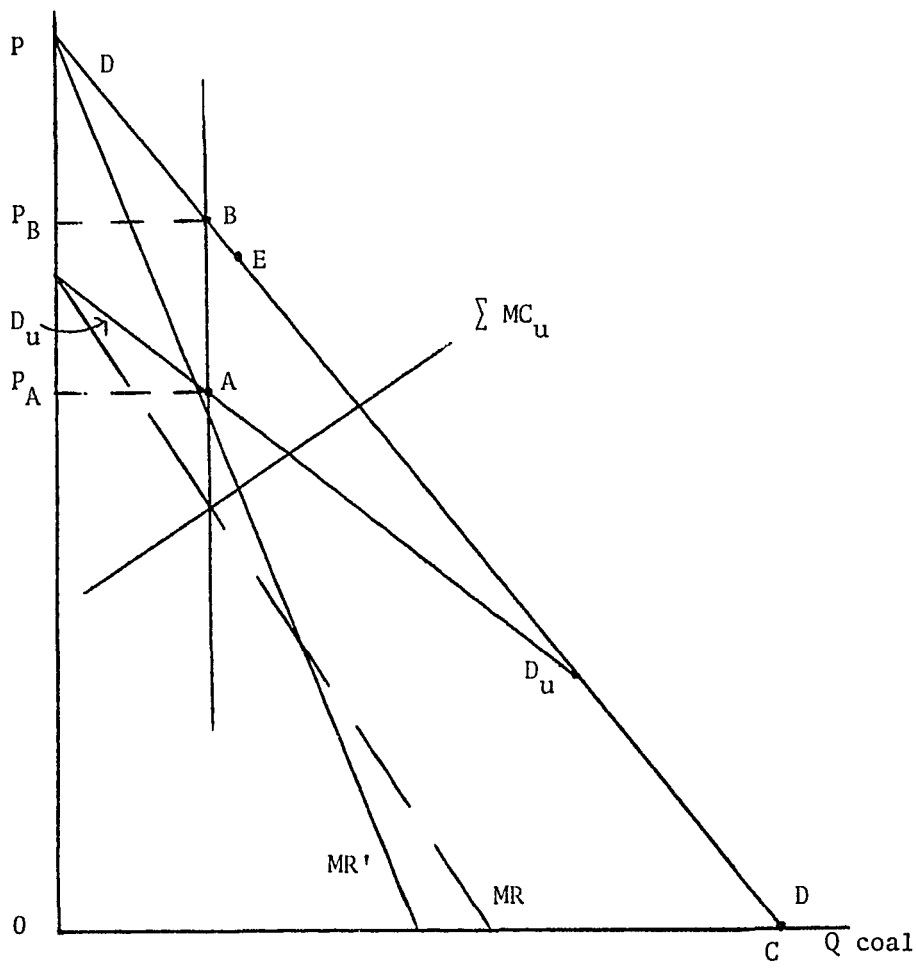

FIGURE V-5: Case in which monopoly output without non-union sector is greater than monopoly output with non-union sector.

royalty increased after a long period of stability.[34]

An Aside on Williamson's "Wage Rates as a Barrier to Entry"[35]

Williamson's 1968 article dealt with the Supreme Court finding in the Pennington case[36] that the UMW and the BCOA had conspired to set a wage high enough to drive out small unionized firms and benefit workers in the large firms and owners of the large firms. Although this case is somewhat different from the one discussed above, the analysis used above can be used to fill a gap in Williamson's article. Williamson models a situation in which large mines have a capital-intensive production process and small mines have a labor-intensive production process. Although Williamson assumes fixed coefficients, this assumption could be relaxed and his qualitative conclusions still hold as long as at each wage-rental ratio, the capital-labor ratio is higher in large mines. Williamson concluded that there are indeed conditions under which large mine-owners would have an incentive to impose a high wage bargain on small mine-owners, although implicit throughout is the assumption that small unionized mine-owners will not de-unionize in response to the higher wage. However, Williamson's conclusion requires that it be easy for the large remaining firms to collude and set the monopoly price. He admits[37] that the coal industry is very unconcentrated but does not seem to be aware that this will cause any of the usual price-fixing agreements to break down. Now we can see how the royalty can save Williamson's analysis. Even though it is hard to collude on price normally, the UMW and the BCOA can collude indirectly by setting the royalty when they bargain over wages. This is the missing link in Williamson's model.

Other Evidence for the Barrier to Entry Hypothesis

An indirect way to test the BTEH further is to see if other behavior of the UMW and/or the BCOA is consistent with the hypothesis. Much of the past behavior is consistent. We turn to an examination of this behavior.

The UMW Violence Campaign

Throughout the period from 1948 to 1959, the United Mine Workers union engaged in a systematic terrorist campaign against non-union coal mine workers and non-union employers.[38] The reason was to establish a credible threat to discourage workers and employers from trying to operate in a non-union environment.[39] However, the National Labor Relations Board imposed huge fines on the UMW, thus effectively discouraging them from continuing the violence campaign.[40] It is clear how the violence campaign is consistent with the BTEH.

The Use of the Walsh-Healey Act

In the early 1950's the Tennessee Valley Authority increased its demand for coal,[41] and bought it on a competitive bidding basis. In December 1954, the UMW and two large coal companies, Pittsburgh-Consolidation Coal Company and Pocahontas Fuel Company, petitioned the Secretary of Labor for a determination of prevailing minimum wages under the Walsh-Healey Act.[42] Under the Walsh-Healey Act, firms which sold more than $10,000 of goods annually to the Federal Government had to pay wages greater than or equal to the wage which the Department of Labor found to be the "prevailing" wage in the area.[43] The Secretary of Labor announced in September 1955 that the prevailing

wage was the wage then in the contract between the UMW and the BCOA.[44] However, every time the union scale wage was increased there was a gap between the Walsh-Healey wage and the UMW wage, since it took time for the government to hold hearings and "redetermine" the prevailing wage. Moreover, non-union firms still did not have to pay the 40 cents per ton UMW royalty since this was not determined to be part of the prevailing wage.[45]

In response to this change in constraint, many non-union operators vertically disintegrated (on paper).[46] That is, their tipple where the mined coal was taken for screening, was set up as a separate corporation and the few workers at the tipple were paid the prevailing UMW wage. This tipple then bought coal from a mine owned by the same person who owned the tipple. However, the mine did not pay the prevailing wage. Rather, it paid a lower wage but was not technically in violation of the law since the tipple, not the mine, sold coal to the TVA.

For these reasons, viz., the lag in adjustment of the prevailing wage, the lack of a requirement to pay the UMW royalty, and the vertical disintegration as a way around the constraint, the Walsh-Healey wage determination was not as effective as the UMW and the two large coal companies presumably had hoped it would be. But it is clear how their role in petitioning for the Walsh-Healey wage determination is consistent with the BTEH.

The Protective Wage Clause

The UMW and the unionized mines were not stopped by the NLRB decision on the UMW's use of violence to eliminate non-union mines.

Nor were they stopped by the fact that the application of the Walsh-Healey Act to non-union mines was not very effective. They tried a new tack.

In the contract between the UMW and the BCOA of December 1, 1958,[47] a new clause, the Protective Wage Clause, appeared. This clause stated that any coal bought by mine operators in the BCOA from any other producer, had to be mined under terms and conditions which were at least as favorable as the UMW terms. That is, the Protective Wage Clause banned the purchase of non-union coal by unionized firms in all but name. It is clear how the Protective Wage Clause would benefit union workers by shifting demand from non-union coal to union coal. What may not be as clear is how the Protective Wage Clause could benefit unionized coal companies even though it imposed another constraint on them, namely, the constraint that they could no longer purchase non-union coal for processing. The relevant point is that the Protective Wage Clause imposed a constraint on all unionized coal firms. Firms in an industry often desire constraints on all the firms in that industry. Ideally, of course, a firm would want all firms but itself to be constrained.

Under certain fairly weak assumptions, it can be shown that it would be in the interest of the BCOA to consent to a self-denying ordinance by which it was prevented from buying non-union coal, with no quid pro quo on the part of the UMW. The proof is as follows.

Assume that the elasticity of demand for coal is less than unity at the price before the non-union boycott. Now the BCOA passes a rule prohibiting its members from buying coal from non-union mines. This

means that it will be more costly for non-union mines to put their coal on the market. Therefore less non-union coal will be produced. With a fixed output from BCOA members, the market price will rise. Therefore total revenue will increase and the BCOA members will be better off, assuming that the lost profits from foregoing processing the non-union coal are small.

Now relax the assumption of fixed BCOA output. When output is allowed to vary, it is clear that at a higher price, more output will be supplied by BCOA firms. However, they are not going to expand output enough that the total supply will be as high as it was before the boycott, since, if they did, this would mean that it was profitable for each firm to produce more coal at the old price than it was producing before the boycott. If such coal had been profitable to produce, each firm would have already been producing at that level. Therefore, the equilibrium output will be lower than before the boycott and price will be higher. BCOA firms will receive this higher price on all the units they were previously producing and therefore their profits from this coal will be higher. As long as they break even on the new units produced (and they will, or else they would not be producing them), they will be better off, ignoring the profits foregone on processing non-union coal. It the latter are suitably small, the BCOA will be a net gainer from the restriction.

Of course, the effects of such a restriction would not be symmetrically distributed over firms. Firms which specialized in buying non-union coal for resale would be made worse off. Since side payments are illegal, such an agreement might be difficult to reach even if it

is in the "aggregate" interest of the BCOA to have a restriction on non-union coal. Union producers in Virginia and eastern Kentucky, to whom many of the non-union operators did sell their coal, were reluctant to agree.[48] In fact, in eastern Kentucky, the UMW struck to force acceptance of the Protective Wage Clause.

If in fact the BCOA could gain from a boycott on non-union coal, the question arises why the BCOA waited for the UMW to ask for a boycott and did not take unilateral action. The answer lies possibly in the fact that many coal operators feared an antitrust suit since the purpose of unilateral action on the part of operators would be obvious. In fact, some operators feared an antitrust suit over the Protective Wage Clause.[49] Christenson reports[50] that in spite of published reports that the BCOA was brought kicking and screaming to the agreement under union pressure, a management official suggested to him that the BCOA had been as in favor of the clause as the UMW, if not more so.

However, on September 14, 1959, Congress passed the Landrum-Griffith Act which prohibited secondary boycotts. This law came into effect on November 13, 1959. On November 10, 1959, John Lewis announced a lifting of the boycott on non-union coal for fear of a suit under the Landrum-Griffith Act.[51]

The long-run response to the Landrum-Griffith Act came when the next contract was negotiated in 1964.[52] In this contract,[53] rather than have a complete boycott of non-union coal, the participants agreed to require a royalty to be paid on every ton of non-union coal bought by a union firm equal to $.80 or twice the $.40 per ton royalty rate on union coal. However, the National Labor Relations Board ruled

that such a double royalty violated the ban on secondary boycotts.[54]

It is clear that either form of the boycott on non-union coal would benefit the UMW and might benefit the BCOA by restricting non-union mines. However, the NLRB did not allow the BCOA to boycott non-union coal. The UMW had tried using the Walsh-Healey Act and had found it to be less effective than they wanted. Finally they had tried enforcing a boycott of non-union coal by union mines. This had been found illegal by the NLRB. In each case, their target was the non-union mines. All this evidence suggests that they wanted very much to get rid of the small, non-union mines. Since they failed in their use of each of these methods, it seems plausible that they would turn to some other tactic to achieve their objective. The tactic of lobbying for safety seems in retrospect to be a good one. After all, being against safety is like being against motherhood. Moreover, it would achieve the goal indirectly where more direct methods whose purpose was obvious had failed.

Evidence Against the BTEH

There is some evidence against the BTEH. One piece of evidence was presented in the section on the MWP. There it was shown that returns on coal company stocks were lower than would have been predicted through the period of consideration and passage of the 1966 bill. However, it was also pointed out that this piece of evidence did not support the MWP. Possibly there was some other disturbance at the time (or, more correctly, some anticipated disturbance) which had a negative effect on the value of coal companies.

The other evidence on rates of return on coal company stocks during the consideration, passage, and first year of the 1969 Act, is consistent with the BTEH and inconsistent with the MWP. As will be recalled, the returns on coal company stocks were higher than would have been predicted on the basis of the earlier period.

Another possible piece of evidence against the BTEH comes from Chapter IV. It was shown there that the 1969 Act raised the cost of coal mining significantly. Why would the large coal companies and the UMW lobby for restrictions that raised the cost of coal? These restrictions could have been agreed to in their contract if the gains in increased safety had outweighed the loss in the form of decrease productivity. One would expect that the large firms and the UMW would lobby for legislation which constrained everyone but them.

The answer is threefold. First, careful reading the the testimony of the BCOA and National Coal Association representatives' testimony reveals that they did not agree uniformly with the regulations being imposed. In the House Hearings of 1969,[55] they recommended a higher maximum dust standard than the Bureau of Mines wanted, opposed the requirements for roof support, opposed some of the ventilation requirements for gassy (generally large) mines, and opposed the large amount of discretionary power given to the Secretary of the Interior.

On the other hand, the large mine operators vigorously supported the elimination of the gassy-non-gassy distinction.[56] This is what the BTEH predicts.

The position of the UMW is less clear. They supported the more stringent dust standards recommended by the Bureau of Mines and wanted

a permanent inspector at every gassy mine that eliminated a large quantity of gas.[57] On the other hand, they supported the elimination of the gassy-non-gassy distinction. This is consistent with the BTEH. Moreover, the UMW-drafted bill, H.R. 7747 and S. 1178, which was not the final bill accepted, made safety standards a matter of statute and not of discretionary choice by the Secretary.[58] They agreed with the large mine operators about the danger of giving the Secretary of the Interior discretionary power.

Second, to the extent that the cost of coal mining increased, the price would increase, and people would substitute into other fuels, for example, oil. Owners of oil or of specific capital in the oil industry would benefit from the price increase due to the legislation. Therefore one would expect to see owners of oil lobbying for the 1969 Act. In fact, they did. Six of the largest 14 coal companies (in 1974) were owned by oil companies. They were Consolidation Coal Company (owned by Continental Oil and Gas Corporation and number two in production), Island Creek Coal Company (owned by Occidental Petroleum Corporation and number three in production), Amax Coal Company (owned by Standard Oil of California and number four in production), Arch Mineral Corporation (owned by Ashland Oil, Incorporated and number seven in production), Old Ben Coal Company (owned by Standard Oil of Ohio and number 11 in production), and Pittsburgh and Midway Coal Mining Company (owned by Gulf Oil Corporation and number 14 in production).[59] These coal companies were represented by the BCOA and the National Coal Association.

Third, whatever the intent of the BCOA and the UMW, it is naive to expect that only their views will prevail. As Peltzman has pointed out,[60] the identification of regulation with any single interest will not in general be a result of regulation. Rather, in this case, interests other than those of the union coal mine owners and unionized workers were catered to by politicians. Specifically, the Bureau of Mines gained from this regulation. The inspection force increased significantly[61] and the Secretary of the Interior was given a large amount of discretionary power.

Evidence that the cost of coal mining increased even in unionized mines does constitute evidence against the hypothesis that the only purpose of the legislation was to wipe out non-union mines. However, it is not evidence against the hypothesis that the elimination of non-union mines was one of the purposes of the legislation.

A Note on the Optimality of the Legislation

Even if one accepts the conclusion that the legislation eliminated small non-union mines and that the intent of the large mine owners and the United Mine Workers was to do just that, one still does not have to accept the conclusion that the elimination of non-union mines was necessarily bad from an efficiency standpoint.[62] Possibly these non-union mines "should have" been eliminated on grounds of efficiency. Adam Smith reminds us that, "It is not from the benevolence of the butcher, the brewer, or the baker, that we expect our dinner, but from their regard to their own interest."[63] Even if it was not part of their intent, the UMW's and BCOA's actions might have been efficiency-promoting, if the effect of the legislation were to eliminate the more

dangerous mines and these mines had employed workers who would not have worked in these mines, if they knew the real risk, at any wage the operator could feasibly pay. This could happen if workers at these mines consistently underestimated the risk of working in these small mines.

There is good evidence that the fatality rate per manhour (the relevant rate from the worker's point of view) is higher the smaller the mine, although the non-fatal injury rate does not follow the same pattern. Table V-2 gives the fatality rates per manhour for mines in various labor force size categories averaged over the period from 1960 to 1965. As can be seen, the rate falls with the labor force size. This is evidence that small mines are less safe. It is not evidence that small mines have less than optimal safety. The higher fatality rate in small mines could be due to economies of scale in safety production or it could be due to the fact that the smaller the mine, the less likely it is to be unionized, and therefore the lower the wage, and if safety is a normal good, the lower the optimal amount of safety.

In order to rationalize the differential effects of the legislation on non-union mines from an efficiency viewpoint, one would have to postulate that not only did non-union workers underestimate the risk of working in a non-union mine, but also that union workers had a more correct estimate of the risk. There are two indirect tests of this hypothesis.

First, if non-union workers are more ignorant than union workers, one would expect some kind of learning to occur over time. This

TABLE V-2: Fatality Rates in Underground Bituminous Coal Mines by Size of Labor Force, 1960-1965 Average

LABOR FORCE SIZE (MEN)	FATALITY RATE PER MILLION MAN-HOURS
1-4	1.94
5-9	1.97
10-19	1.64
20-49	1.51
50-99	1.37
100-249	1.21
250+	.84

learning should, if non-union workers really had underestimated the risk, result in a relative shrinking of the non-union sector over time.

As Table V-3 shows, the opposite occurred. Since Title I mines are likely to be non-union mines and Title II mines are likely to be union mines, the ratio of the two gives approximately the ratio of the number of non-union mines to the number of union mines. The ratio of Title I mines to Title II mines rose from 3.70 in 1955 to 6.22 in 1964. The ratio of the output of Title I mines to the output of Title II mines rose from .08 in 1954 to .18 in 1963. Finally, the ratio of men employed in Title I mines to men employed in Title II mines rose from .16 in 1954 to .42 in 1963. All this evidence suggests that the non-union sector expanded significantly from 1954 to 1964. Thus the union-non-union differential ignorance hypothesis fails the first test.

Second, the claim that non-union workers bias downward the risk of working in a non-union mine more than union workers bias downward the risk of working in a mine (union or non-union) has implications for the characteristics of workers. In the words of Adam Smith, "The contempt of risk and the presumptuous hope of success, are in no period of life more active than at the age at which young people chuse their professions."[64]

That is, we would expect young workers, due to lack of experience or of information, to bias the risk downward more than old people.[65] Therefore, we would expect that if non-union workers do bias downward the risk of working in non-union mines relative to union workers, that the average age of an ignorant non-union worker would be lower than the average age of an informed union worker.

TABLE V-3: Ratio of Number of Mines, Output, and Employment in Title I Mines to Number of Mines, Output and Employment, Respectively in Title II Mines.

YEAR	TITLE I MINES / TITLE II MINES	TITLE I OUTPUT / TITLE II OUTPUT	TITLE I WORKERS / TITLE II WORKERS
1954		.08	.16
1955	3.70	.10	.20
1956	4.08	.10	.19
1957	4.96	.13	.20
1958	5.39	.13	.26
1959	6.08	.14	.30
1960	6.57	.15	.34
1961	6.57	.17	.39
1962	6.25	.18	.41
1963	5.92	.18	.42
1964	6.22		

I have found two pieces of evidence on this. First, in the Hearings on the various legislation referenced in footnote 1 of this Chapter, it was often pointed out that employees of small Title I (and therefore presumably non-union) mines tended to be older than their counterparts in union mines. This is contrary to the hypothesis.

Second, data on ages and union status of workers in coal mining were taken from the Survey of Economic Opportunity (SEO) tape for 1967. There were 30 union workers and 15 non-union workers in the sample. The mean ages of union and non-union workers were compared. The mean age of union workers was 45 years and of non-union workers was 46 years. The difference between these means was not significant. This result is also contrary to the hypothesis.

Therefore, on the basis of these tests at least, we must reject the hypothesis that non-union workers biased downward the risk of working in a non-union mine. This casts doubt on the idea that the elimination of non-union mines was optimal.

Conclusion

In conclusion, the evidence strongly supports the hypothesis that the small mines eliminated by the 1966 and 1969 legislation were mainly non-union. Most of the evidence supports the hypothesis that the reason the United Mine Workers and the large unionized mining firms supported the legislation was to eliminate the non-unionized sector.

FOOTNOTES

1. See U.S., Congress, House, Committee on Education and Labor, Prevention of Major Disasters in Coal Mines, Hearings on H.R. 7408, 82d Cong., 2d sess., 1952, pp. 167, 189, 199 and 200; U.S., Congress, Senate, Committee on Labor and Public Welfare, Amending the Coal Mine Safety Act, Hearings before the Subcommittee on Labor on S. 743, S.1562, and S. 2403, 86th Cong., 1st sess., 1959, p. 122; U.S., Congress, House, Committee on Education and Labor, Mine Safety, Hearings on H.R. 1098 and similar bills, 86th Cong., 1st sess., 1959, p. 132; U.S., Congress, House, Committee on Education and Labor, To Amend the Federal Coal Mine Safety Act, Hearings before the Select Subcommittee on Labor on H.R. 4237, 87th Cong., 1st sess., 1961, p. 8; U.S., Congress, House, Committee on Education and Labor, Amendments to Federal Coal Mine Safety Act, Hearings before the General Subcommittee on Labor on H.R. 23 and similar bills, 88th Cong., 1st sess., 1963, pp. 100, 245, 407 and 408; U.S., Congress, House, Committee on Education and Labor, To Amend the Federal Coal Mine Safety Act, Hearings before the General Subcommittee on Labor on H.R. 3584, 89th Cong., 1st sess., 1965, p. 100.

2. See U.S., Department of Labor, Bureau of Labor Statistics, Industry Wage Survey: Bituminous Coal Mining, Bulletin No. 1583 (1968), p. 3.

3. The National Coal Association, an association of the larger mining companies, lobbied for the 1969 bill. The Bituminous Coal Operators Association, an association of generally large mines and large mine companies, lobbied for the Amendments to the 1952 Act in their 1961 form but not the 1966 Act itself. There appear to have been no large coal companies lobbying for the 1966 Act. This could possibly be explained by the fact that passage in 1965 and 1966 appeared a sure thing. The House vote on the 1966 Act in 1965 was 336 for and 42 against. See Congressional Quarterly Almanac 21 (1965): 388. However, the United Mine Workers lobbied for all the Acts, as did the Bureau of Mines.

4. See U.S., Congress, House, Committee on Education and Labor, To Amend the Federal Coal Mine Safety Act, Hearings before the General Subcommittee on Labor on H.R. 3584, 89th Cong., 1st sess., 1965, pp. 444-446.

5. See U.S., Department of Labor, Industry Wage Survey: Bituminous Coal Mining, p. 3.

6. I am indebted to Ben Klein for this phrase.

7. See Finley, Corrupt Kingdom, p. 252; and J. Davitt McAteer, Coal Mine Health and Safety: The Case of West Virginia, (New York: Praeger 1973), pp. 57 and 80.

8. Finley, Corrupt Kingdom, pp. 238-249, gives evidence of this.

9. See McAteer, Coal Mine Health and Safety, pp. 37-70.

10. See U.S., Congress, House, Committee on Education and Labor, To Amend the Federal Coal Mine Safety Act, Hearings before the General Subcommittee on Labor on H.R. 3584, 89th Cong., 1st sess., 1965, pp. 192-239; U.S., Congress, House, Committee on Education and Labor, Coal Mine Health and Safety, Hearings before the General Subcommittee on Labor on H.R. 4047, H.R. 4295 and H.R. 7976, 91st Cong., 1st sess., 1969, pp. 226-254; and U.S., Congress, Senate, Committee on Labor and Public Welfare, Coal Mine Health and Safety, Hearings before the Subcommittee on Labor on S. 355 and similar bills, 91st Cong., 1st sess., 1969, pp. 454-483.

11. Quoted in McAteer, Coal Mine Health and Safety, p. 57.

12. See footnote 3.

13. The returns are calculated at the end of each month.

14. I wish to thank Ross Watts and Wayne Mikkelson for their help on this test.

15. Except for Peabody, for which the beta coefficient was calculated for the period from April 1966 to December 1966.

16. To make sure that large coal companies did own primarily large mines, I randomly chose two state reports, the Kentucky, Department of Mines and Minerals, Annual Report for 1963 and the West Virginia, Department of Mines, Annual Report for 1965, and calculated the share of some randomly chosen large firms' output produced in large mines. For Kentucky, the share was calculated in only one county (Pike) due to high computation costs. The shares of output of Bethlehem Mines Corporation, Eastern Coal Corporation, and Republic Steel Corporation produced in large mines were all 100 percent in Pike County. For West Virginia, the shares of output of Bethlehem, Clinchfield (Pittston), Semet-Solvay (Allied Chemical), Union Carbide, Armco Steel, Christopher Coal, Rochester-Pittsburgh, and Westmoreland produced in large mines were all 100 percent. For Island Creek, the share of output produced in large mines was 99.7 percent.

17. From the workers' viewpoint, the 1969 Act did reduce the risk of fatal injury. Even though the 1969 Act did not reduce the fatality rate per ton of coal, it reduced the fatality rate per manhour worked. The evidence is not yet in on the effect of the 1969 Act

17. (contd.) on non-fatal injuries and on black lung.

18. In 1967, the average hourly wage of underground miners in unionized mines was $3.52 and in non-union mines was $2.39. For a given occupation, the union wage exceeded the non-union wage by anywhere from $.66 to $1.66. See U.S., Department of Labor, Industry Wage Survey: Bituminous Coal Mining, pp. 7 and 10.

19. Note the similarity to the dominant firm model.

20. Goldstein and Smith, "Black Lung Benefits," and Maddala, "Productivity and Technological Change" give evidence that the long-run supply curve for coal is horizontal. However, all of the above argument holds if the short-run supply curve is less than perfectly elastic. It is bound to be because of the lag between a price increase and an increase in output. In that case, firms would earn short-run rents by wiping out non-union producers.

21. See Finley, Corrupt Kingdom, pp. 178-204.

22. This point was made independently by G. Warren Nutter, "The Limits of Union Power," in The Public Stake in Union Power, ed. Philip D. Bradley (Charlottesville: University of Virginia Press, 1959), pp. 284-300.

23. See A.J. Liebling, The Earl of Louisiana (London: W.H. Allen, 1962), p. 42. I wish to thank Walter Oi for asking me this precise question. I was forced to think about an issue that I had ignored till then and I have come up with the answer presented here. I wish to thank him also for another reason. In the workshop where he raised the question, I was the only other person in the room who knew of his reference to the Liebling book. My impression at the time was that knowledge assured my future employer of my wide knowledge and helped me get a job offer.

24. Since, if discrimination is costless a monopolist can do better than the single-price monopoly solution by perfectly price-discriminating. The usual assumption is that the cost of such discrimination is less than the benefits to the monopolist.

25. See Finley, Corrupt Kingdom, p. 14.

26. A lump-sum tax is the feasible alternative in this case because a single mine's output would have a negligible effect on the price of coal. The lump-sum tax could be imposed by keeping the piece-rate system and setting a minimum output quota. As Cheung has shown, such a piece-rate system is piece-rate in name only. See Steven N.S. Cheung, The Theory of Share Tenancy (Chicago: University of Chicago Press, 1969). The above analysis of the monopolizing effects of a per ton royalty holds only when the royalty is imposed and enforced on a large fraction of output.

27. Another important reason for setting a royalty which goes to a general pension fund, as does the coal royalty, is that when the pension is received by the worker, he is in a lower tax bracket than if he received payment directly.

28. I am indebted to John Diehl for this suggestion.

29. See footnote 18.

30. This must be. If DD were not higher than $D_u D_u$ (that is, if the relevant region were down the demand curve from point A), then the price would have been too low to attract the non-union firms. There would have been no such firms initially.

31. If the marginal cost curve were horizontal the marginal cost would be the same, and the result would still follow.

32. All elasticities are in terms of absolute values.

33. The proof is as follows: Imagine a straight-line demand curve through point C and point A. Obviously, the elasticity of demand of this imaginary demand curve is less than E_A since the price and quantity are the same but the slope of the imaginary demand curve is lower. But we also know that the elasticity of this demand curve is equal to E_B. See H.A. John Green, Consumer Theory (Baltimore: Penguin Press, 1971), p. 60. Therefore E_A is greater than E_B. QED.

34. See Chapter IV.

35. Oliver E. Williamson, "Wage Rates as a Barrier to Entry," Quarterly Journal of Economics 82 (February 1968): 85-116.

36. United Mine Workers v. Pennington, 85 S. Ct. 1585 (1965).

37. Williamson, "Wage Rates," pp. 110-111.

38. The violence campaign, which even included murder, is well documented in Finley, Corrupt Kingdom, pp. 136-158.

39. Note that this is a literal case of predatory behavior. If this behavior had been successful, then more conventional threat behavior (e.g., predatory pricing) could possibly be successful. The McGee argument, that predatory pricing imposes losses on both predator and prey, can be used in this context also. There was loss of life, loss of capital equipment destroyed by dynamite, and lost output due to the violence campaign. Also the predator (UMW) invested a lot of resources in its campaign. These losses could have been avoided by an agreement between the parties.

39. (contd.) But there was no such agreement. The UMW presumably decided that it was cheaper to use coercion than to come to a peaceful agreement. The problem with the McGee argument is that it does not allow for threat behavior. See John S. McGee, "Predatory Pricing: The Standard Oil (N.J.) Case," Journal of Law and Economics 1 (October 1958): 137-169.

40. It took 8 years for the first fine to be collected. This would explain why the violence campaign lasted so long.

41. See Finley, Corrupt Kingdom, p. 136, and Carroll L. Christenson, Economic Redevelopment in Bituminous Coal (Cambridge: Harvard University Press, 1962), p. 262.

42. See Christenson, Economic Redevelopment, p. 263.

43. Pub. L. 74-846 (June 30, 1936), Government Contracts Act. 49 Stat. 2036.

44. Christenson, Economic Redevelopment, p. 266.

45. Christenson, Economic Redevelopment, p. 266.

46. Finley, Corrupt Kingdom, p. 147.

47. See "National Bituminous Coal Wage Agreement of 1950 as Amended Effective December 1, 1958."

48. Christenson, Economic Redevelopment, p. 269.

49. Christenson, Economic Redevelopment, p. 269.

50. Christenson, Economic Redevelopment, p. 269.

51. New York Times, 10 November 1959.

52. For some reason, possibly the recession, a new three year contract was not negotiated in 1961.

53. See "National Bituminous Coal Wage Agreement of 1950 as Amended Effective April 2, 1964."

54. New York Times, 20 March 1966.

55. See U.S., Congress, House, Coal Mine Health and Safety Hearings, 1969, pp. 121, 151-153.

56. See U.S., Congress, House, Coal Mine Health and Safety Hearings, 1969, pp. 142 and 209.

57. See U.S., Congress, House, Coal Mine Health and Safety Hearings, 1969, pp. 230 and 233.

58. See U.S., Congress, House, Coal Mine Health and Safety Hearings, 1969, p. 112.

59. Data are taken from U.S., Council on Wage and Price Stability, A Study of Coal Prices (1976), p. 97.

60. Sam Peltzman, "Toward a More General Theory of Regulation," (unpublished manuscript, University of Chicago, 1976).

61. See Chapter IV above.

62. Although one must still conclude that, insofar as the elimination of non-union mines strengthened the monopoly position of the unionized sector, efficiency did suffer.

63. Adam Smith, Wealth of Nations 1, p. 16.

64. Adam Smith, Wealth of Nations 1, p. 110.

65. Although it should be noted that Smith does not give much support for his position. He goes on to discuss some of the occupational choices youth make which are risky, but he points out that invariably they contain an element of excitement, something which appeals particularly to youth. He further points out that dangers which youth know about but which can be surmounted appeal to youth while mere unwholesomeness repels. See Smith, Wealth of Nations, pp. 111-112. All of this seems to be evidence that youth have different tastes rather than that youth are ignorant.

CHAPTER VI

SUMMARY AND CONCLUSIONS

In this study I have examined the case for government regulation of safety on the grounds of imperfect worker information, monopoly in the labor market, and economies of scale in the production of safety. I have found in each case that none of the above conditions is in itself sufficient justification for government regulation. Each condition requires that the government act "correctly" even though it is not stated by proponents of government intervention how the government officials are to be motivated to act correctly. The imperfect worker information argument and the economies of scale argument for government intervention both require that the government have information which private economic units do not have. The labor market monopoly argument for intervention turns out to be an argument for further government intervention to correct the distortions caused by existing government intervention.

In my study of the effects of actual government intervention in safety in underground coal mining, I have found that, to the extent we can measure the effects, only one Act of the three, the 1966 Act, had any role in increasing safety. However, all three Acts, especially the 1969 Act, caused an increase in the cost of producing coal. Moreover, the 1966 and the 1969 Acts appeared to impose larger costs per unit of output on small mines, as evidenced by the fact that there was a dramatic exit of small mines from 1966 to 1974.

In light of the fact that one of the main effects of the 1966 and 1969 Acts was the exit of small mines which were generally not unionized by the United Mine Workers union, I have given evidence supporting the hypothesis that the UMW and the unionized firms supported the 1966 and 1969 Acts to eliminate potential competition from the non-union mines.

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APPENDIX

Table A-1: Number of Title I mines by year and state, 1948-1961.

STATE	YEAR 1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
ALABAMA	256	280	273	281	381	397	285	241	198	188	118	142	154	129
COLORADO	150	150	156	176	136	132	129	120	113	100	106	105	93	91
ILLINOIS	66	89	81	99	84	80	71	57	50	39	17	31	24	22
INDIANA	34	39	30	31	31	26	33	34	32	28	21	24	22	24
KENTUCKY	2368	1381	1229	2594	1849	1651	1553	1565	1878	1722	1853	1701	1953	1558
OHIO	332	326	438	403	328	318	319	239	206	145	172	167	146	134
PENN.(BITUM).	681	785	690	644	609	622	553	703	885	852	1091	999	955	929
TENNESSEE	104	105	131	308	476	798	647	633	593	510	543	471	388	443
UTAH	35	44	47	38	37	40	37	33	32	29	27	32	29	24
VIRGINIA	182	271	63	107	183	187	362	885	844	1103	916	1208	1156	1111
WEST VIRGINIA	294	532	504	503	617	426	508	689	883	938	1026	1018	1319	1216
PENN.(ANTHR.)	179	137	136	154	170	172	153	1217	1140	1140	1097	1040	996	1015

Table A-2: Number of Title II mines by year and state, 1948-1961.

STATE	YEAR 1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
ALABAMA	134	115	92	78	63	56	49	38	30	22	37	25	25	26
COLORADO	59	48	44	41	40	30	23	20	21	21	26	17	18	17
ILLINOIS	169	145	147	132	112	85	71	55	47	43	59	39	37	35
INDIANA	35	35	36	39	26	20	14	12	12	12	19	12	13	12
KENTUCKY	510	489	841	369	390	322	320	303	299	257	218	204	184	200
OHIO	119	117	93	73	68	59	47	41	39	32	28	27	27	21
PENN.(BITUM.)	641	535	522	431	383	307	238	216	208	184	162	142	126	108
TENNESSEE	55	57	53	57	39	37	31	37	43	33	59	27	31	25
UTAH	21	27	24	23	21	19	19	19	20	19	22	14	18	18
VIRGINIA	87	89	95	85	126	169	106	106	81	75	144	74	82	77
WEST VIRGINIA	749	765	740	711	644	527	437	442	453	439	422	368	349	333
PENN.(ANTHR.)	232	217	210	222	201	171	136	119	114	119	83	73	59	43

Table A-3: Ratio of Title I bituminous mines to total underground bituminous mines, 1948-1962.

YEAR	RATIO
1948	.64
1949	.63
1950	.53
1951	.69
1952	.67
1953	.72
1954	.73
1955	.77
1956	.79
1957	.80
1958	.82
1959	.83
1960	.84
1961	.83
1962	.83

Table A-4: Ratio of number of Title I mines to total number of underground mines, by state, 1948-1961 (1948-1962 for Pennsylvania anthracite).

STATE	YEAR 1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
ALABAMA	.66	.71	.75	.78	.86	.88	.85	.86	.87	.90	.76	.85	.86	.83	
COLORADO	.72	.76	.78	.81	.77	.81	.85	.86	.84	.83	.80	.86	.84	.84	
ILLINOIS	.28	.38	.36	.43	.43	.38	.50	.51	.52	.48	.22	.44	.39	.39	
INDIANA	.49	.53	.45	.44	.54	.57	.70	.72	.73	.70	.53	.67	.63	.67	
KENTUCKY	.82	.74	.59	.88	.83	.84	.83	.84	.86	.87	.89	.89	.91	.89	
OHIO	.74	.74	.82	.85	.83	.84	.87	.85	.84	.82	.86	.86	.84	.86	
PENN.(BITUM.)	.52	.59	.57	.60	.61	.67	.70	.76	.81	.82	.87	.88	.88	.90	
TENNESSEE	.65	.65	.71	.84	.92	.96	.95	.94	.93	.94	.90	.95	.93	.95	
UTAH	.63	.62	.66	.62	.64	.68	.66	.63	.62	.60	.55	.70	.62	.57	
VIRGINIA	.68	.75	.40	.56	.59	.53	.77	.89	.91	.94	.86	.94	.93	.94	
WEST VIRGINIA	.28	.41	.41	.41	.49	.45	.54	.61	.66	.68	.71	.73	.79	.79	
PENN.(ANTHR.)	.44	.39	.33	.31	.40	.41	.48	.89	.89	.90	.92	.92	.93	.95	.97

Table A-5: Ratio of number of mines in each labor force size category to total number of mines, bituminous, 1948-1965.

LABOR FORCE SIZE (MEN)	YEAR 1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
1-4	.17	.21	.20	.28	.33	.35	.33	.34	.44	.36	.42	.40	.47	.39	.44	.48	.48	.45
5-9	.32	.24	.19	.31	.26	.27	.29	.33	.26	.33	.25	.33	.26	.34	.28	.27	.25	.28
10-14	.15	.18	.14	.09	.09	.10	.11	.10	.09	.10	.14	.10	.11	.11	.12			
15-19			.098	.050	.058	.048	.052	.042	.039	.039	.041	.036	.042	.043	.047			
20-24			.060	.032	.029	.026	.029	.028	.024	.023	.022	.019	.019	.020	.023			
25-49	.085	.094	.113	.071	.075	.067	.060	.058	.050	.041	.041	.041	.034	.040	.037			
50+	.201	.211	.193	.153	.164	.144	.130	.107	.095	.096	.077	.074	.066	.063	.059	.055	.059	.061

Table A-6: Number of mines in each labor force size category as a fraction of total mines, Pennsylvania anthracite, 1948-1965.

LABOR FORCE SIZE (MEN)	YEAR 1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
1-4	.017	.034	.055	.048	.089	.010	.183	.819	.735	.718	.731	.740	.767	.778	.749	.740	.728	.735
5-9	.224	.169	.156	.157	.226	.219	.173	.050	.111	.133	.142	.135	.133	.132	.173	.150	.149	.152
10-14	.195	.184	.121	.106	.084	.090	.125	.025	.042	.047	.042	.044	.046	.036	.046			
15-19			.040	.082	.059	.102	.069	.012	.026	.021	.019	.014	.013	.019	.009			
20-24			.055	.048	.049	.029	.042	.010	.007	.014	.007	.011	.007	.004	.018			
25-49	.122	.105	.176	.184	.111	.105	.087	.032	.030	.018	.014	.011	.019	.009	.017			
50+	.394	.444	.396	.375	.383	.353	.322	.051	.049	.050	.045	.045	.028	.023	.016	.016	.022	.024

Table A-7: Number of mines in various size categories in Bell County, Kentucky, 1948-1956.

LABOR FORCE SIZE (MEN)	YEAR 1948	1949	1950	1951	1952	1953	1954	1955	1956
1-4	36	71	61	41	61	50	55	53	52
5-9	37	43	74	42	37	43	29	36	45
10-12	15	15	6	5	4	7	8	7	9
13	1	0	1	1	1	5	5	2	2
14	0	1	3	1	2	1	3	2	0
15	2	1	1	2	3	2	0	1	1
16	3	1	0	1	2	1	0	0	1
17-20	6	4	2	3	3	3	0	1	0
21-25	0	0	0	2	1	0	2	3	2
26+	19	20	19	17	16	14	14	10	9

Table A-8: Number of mines in various size categories in Floyd County, Kentucky, 1948-1956.

LABOR FORCE SIZE (MEN)	YEAR 1948	1949	1950	1951	1952	1953	1954	1955	1956
1-4	193	403	59	110	33	65	33	72	113
5-9	264	111	196	89	84	99	118	197	243
10-12	73	26	23	16	18	14	13	33	22
13	3	1	1	1	4	3	2	8	5
14	5	2	4	3	3	5	2	3	9
15	10	4	3	2	1	2	2	6	6
16	6	3	4	1	0	5	2	4	1
17	3	0	0	0	2	0	1	3	2
18	3	2	3	2	1	1	2	2	2
19	2	2	0	0	1	2	0	0	0
20	7	3	1	2	2	1	2	0	4
21-25	4	2	5	1	1	4	1	2	3

Table A-9: Number of mines in various size categories in Harlan County, Kentucky, 1948-1956.

LABOR FORCE SIZE (MEN)	YEAR 1948	1949	1950	1951	1952	1953	1954	1955	1956
1-4	19	44	64	99	27	67	67	82	70
5-9	30	51	70	53	84	29	54	48	53
10-12	3	6	8	8	10	6	10	16	10
13	0	0	1	0	0	2	3	3	1
14	2	0	1	2	1	3	3	0	2
15	2	2	0	1	0	3	0	2	3
16-18	1	2	1	1	3	2	3	4	3
19	1	0	0	0	0	0	0	0	1
20	1	0	0	0	0	0	0	1	1
21-25	0	1	0	0	1	2	5	1	4
26+	54	56	58	49	50	50	44	42	43

Table A-10: Number of mines in various size categories in Letcher County, Kentucky, 1948-1956.

LABOR FORCE SIZE (MEN)	YEAR 1948	1949	1950	1951	1952	1953	1954	1955	1956
1-4	280	764	302	311	122	127	95	124	110
5-9	413	351	306	72	65	97	101	157	162
10-12	53	55	24	16	9	4	22	20	33
13	16	11	4	5	1	3	5	2	4
14	8	4	4	0	2	4	0	6	1
15	11	2	1	5	1	3	1	2	3
16-18	7	7	5	3	1	7	11	6	11
19	1	1	1	0	0	0	2	1	1
20	2	2	4	4	0	1	1	0	2
21-25	2	24	4	2	2	3	5	5	4
26+	10	15	7	7	8	4	13	12	23

Table A-11: Number of mines in various size categories in Pike County, Kentucky, 1948-1956.

LABOR FORCE SIZE (MEN)	YEAR 1948	1949	1950	1951	1952	1953	1954	1955	1956
1-4	325	515	288	193	93	119	78	114	147
5-9	413	181	256	121	127	129	129	231	261
10-12	91	34	44	22	19	24	22	26	38
13	10	4	6	0	3	1	3	7	8
14	11	3	14	3	9	3	6	8	8
15	14	4	11	4	6	5	2	7	4
16-18	20	7	15	7	4	6	4	8	6
19	4	0	0	0	0	3	3	3	2
20	11	9	3	2	3	4	1	2	2
21-25	3	9	17	10	6	7	5	8	3
26+	56	61	53	44	47	30	35	36	31

Table A-12: Number of mines in various size categories in nine major coal-producing counties in West Virginia, 1949-1955.

LABOR FORCE SIZE (MEN)	YEAR 1949	1950	1951	1952	1953	1954	1955
1-5	15	18	12	19	13	16	23
6-10	111	113	93	82	70	101	123
11-13	47	61	38	37	29	28	35
14	16	11	12	7	6	4	2
15	8	9	7	10	2	6	8
16	15	9	9	13	3	6	14
17-20	43	40	35	31	19	22	19
21-25	27	32	26	17	7	10	10
26+	359	364	314	305	270	221	197

Table A-13: Number of mines in various size categories in Indiana, 1948-49 to 1955.

LABOR FORCE SIZE (MEN)	YEAR 1948-49	1949-50	1950-51	1951-52	1952-53	1953-54	1954-55	1955
1-5	0	1	0	22	8	9	12	14
6-10	0	1	2	6	10	12	16	13
11-13	4	7	3	6	4	3	4	5
14	0	1	2	1	0	2	0	0
15	1	0	5	1	1	1	0	0
16	1	0	0	1	2	0	0	0
17-20	0	6	5	4	1	0	0	1
21-25	3	2	0	1	1	1	2	1
26+	30	27	23	18	16	14	10	10

Table A-14: Number of mines in various size categories in Ohio, 1948-1956.

LABOR FORCE SIZE (MEN)	YEAR 1948	1949	1950	1951	1952	1953	1954	1955	1956
1-5	210	206	218	216	161	152	130	118	93
6-10	82	72	76	60	59	44	48	40	28
11-13	24	26	22	20	23	19	18	21	9
14	7	5	7	8	1	4	7	1	9
15	7	10	11	10	8	3	7	9	2
16	10	5	8	7	6	5	3	6	7
17-20	21	24	17	24	17	17	16	7	6
21-25	27	17	15	11	13	12	4	8	3
26+	85	76	68	56	46	38	35	34	30

Table A-15: Fraction of output produced in
Title I, Title II, and non-underground mines, bituminous, 1948-1961.

CATEGORY	YEAR 1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
TITLE I	.045	.051	.043	.046	.047	.046	.058	.067	.069	.082	.082	.086	.091	.097
TITLE II	.718	.703	.722	.736	.721	.718	.684	.673	.653	.644	.617	.603	.600	.580
NON-UNDERGROUND	.237	.246	.235	.217	.231	.236	.258	.260	.278	.274	.301	.311	.313	.323

Table A-16: Title I output as a fraction of total output, by state, 1948-1962.

STATE	YEAR 1948	1949	1950	1951	1952	1953	1954
ALABAMA	.037	.040	.035	.045	.049	.044	.038
COLORADO	.052	.082	.086	.082	.073	.079	.100
ILLINOIS	.00367	.00659	.00467	.00573	.00674	.00713	.00587
INDIANA	.00985	.00840	.00575	.00823	.01271	.00953	.01588
KENTUCKY	.086	.078	.061	.071	.056	.055	.061
OHIO	.030	.028	.030	.033	.026	.027	.028
PENN.(BITUM.)	.019	.022	.019	.018	.023	.019	.020
TENNESSEE	.041	.039	.040	.095	.149	.183	.217
UTAH	.054	.062	.088	.086	.114	.100	.130
VIRGINIA	.039	.080	.013	.015	.044	.043	.100
WEST VIRGINIA	.0065	.0109	.0120	.0122	.0125	.0109	.0147
PENN. (ANTHR.)	.018	.018	.019	.017	.019	.031	.028

STATE	YEAR 1955	1956	1957	1958	1959	1960	1961	1962
ALABAMA	.038	.035	.026	.017	.024	.027	.032	
COLORADO	.108	.089	.086	.064	.104	.098	.092	
ILLINOIS	.00671	.00660	.00559	.00095	.00405	.00505	.00390	
INDIANA	.01514	.01277	.01122	.00663	.01023	.00809	.01106	
KENTUCKY	.071	.076	.075	.080	.068	.087	.088	
OHIO	.024	.020	.018	.023	.018	.017	.016	
PENN.(BITUM.)	.020	.024	.028	.027	.028	.026	.027	
TENNESSEE	.155	.137	.089	.135	.190	.167	.157	
UTAH	.106	.084	.092	.060	.172	.154	.142	
VIRGINIA	.158	.150	.223	.210	.236	.213	.231	
WEST VIRGINIA	.0207	.0237	.0307	.0303	.0286	.0374	.0401	
PENN.(ANTHR.)	.076	.092	.099	.109	.125	.144	.164	.168

Table A-17: Title II output as a fraction of total output, by state, 1948-1962.

STATE	YEAR 1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
ALABAMA	.438	.426	.439	.452	.420	.421	.422	.422	.416	.431	.416	.415	.416	.408	
COLORADO	.434	.402	.391	.395	.397	.396	.374	.349	.367	.366	.397	.352	.349	.371	
ILLINOIS	.423	.414	.410	.404	.389	.386	.382	.371	.370	.358	.349	.337	.331	.327	
INDIANA	.287	.288	.310	.305	.277	.272	.251	.220	.219	.227	.231	.228	.225	.223	
KENTUCKY	.361	.359	.396	.383	.396	.398	.394	.397	.356	.339	.333	.332	.313	.305	
OHIO	.291	.264	.251	.268	.254	.243	.221	.226	.237	.229	.201	.196	.198	.192	
PENN.(BITUM.)	.405	.410	.410	.422	.414	.421	.409	.411	.400	.400	.386	.379	.379	.373	
TENNESSEE	.426	.432	.430	.398	.335	.291	.229	.260	.279	.264	.246	.214	.232	.218	
UTAH	.946	.938	.912	.914	.886	.900	.870	.894	.916	.908	.940	.828	.846	.858	
VIRGINIA	.427	.389	.426	.422	.426	.427	.377	.303	.270	.230	.246	.225	.255	.230	
WEST VIRGINIA	.464	.460	.466	.469	.469	.467	.461	.460	.450	.448	.447	.453	.444	.441	
PENN.(ANTHR.)	.630	.615	.654	.612	.588	.465	.508	.470	.433	.402	.382	.329	.265	.228	.226

Table A-18: Non-underground output as a fraction of total output by state, 1948-1962.

STATE	YEAR 1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962
ALABAMA	.525	.534	.525	.503	.531	.535	.540	.541	.548	.543	.567	.561	.557	.560	
COLORADO	.513	.516	.523	.523	.530	.525	.526	.544	.544	.548	.538	.544	.553	.538	
ILLINOIS	.573	.580	.585	.591	.605	.607	.612	.623	.623	.636	.650	.659	.664	.669	
INDIANA	.703	.704	.684	.686	.711	.718	.733	.765	.768	.762	.762	.762	.767	.766	
KENTUCKY	.553	.563	.544	.546	.547	.547	.545	.532	.568	.586	.588	.600	.601	.607	
OHIO	.679	.708	.719	.699	.720	.730	.751	.750	.743	.753	.775	.786	.785	.792	
PENN.(BITUM.)	.576	.568	.571	.560	.563	.561	.571	.569	.576	.572	.586	.593	.596	.600	
TENNESSEE	.533	.529	.530	.507	.515	.525	.554	.585	.584	.647	.618	.596	.600	.625	
UTAH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
VIRGINIA	.534	.530	.561	.563	.529	.530	.523	.539	.580	.546	.545	.539	.532	.539	
WEST VIRGINIA	.530	.529	.522	.518	.518	.522	.524	.519	.526	.521	.522	.518	.519	.519	
PENN.(ANTHR.)	.352	.367	.326	.371	.393	.504	.464	.453	.475	.499	.509	.546	.591	.608	.606

Table A-19: Fraction of total (underground plus non-underground) output produced in each labor force size category in underground mines, bituminous, 1948-1965.

LABOR FORCE SIZE (MEN)	YEAR 1948	1949	1950	1951	1952	1953	1954	1955	1956
1-4	.0047	.0058	.0045	.0073	.0076	.0078	.0083	.0095	.0167
5-9	.0196	.0181	.0117	.0200	.0172	.0176	.0225	.0237	.0262
10-14	.0211	.0272	.0154	.0121	.0115	.0136	.0166	.0171	.0172
15-19			.0178	.0101	.0131	.0114	.0114	.0098	.0101
20-24			.0134	.0090	.0087	.0078	.0104	.0099	.0097
25-49	.0360	.0379	.0428	.0353	.0384	.0365	.0352	.0383	.0376
50+	.664	.649	.659	.689	.568	.669	.637	.632	.605

LABOR FORCE SIZE (MEN)	YEAR 1957	1958	1959	1960	1961	1962	1963	1964	1965
1-4	.0123	.0156	.0132	.0225	.0136	.0219	.0253	.0263	.0252
5-9	.0392	.0264	.0382	.0297	.0448	.0330	.0352	.0323	.0322
10-14	.0214	.0352	.0241	.0256	.0257	.0297			
15-19	.0116	.0133	.0123	.0160	.0166	.0191			
20-24	.0093	.0102	.0084	.0094	.0109	.0129			
25-49	.0273	.0342	.0338	.0345	.0371	.0373			
50+	.605	.564	.559	.549	.528	.512	.500	.502	.497

Table A-20: Fraction of total (underground plus non-underground) output produced in each labor force size category in underground mines, anthracite, 1948-1965.

LABOR FORCE SIZE (MEN)	YEAR 1948	1949	1950	1951	1952	1953	1954	1955	1956
1-4	.0002	.0005	.0007	.0010	.0021	.0037	.0041	.0509	.0412
5-9	.0056	.0053	.0062	.0087	.0120	.0187	.0088	.0116	.0272
10-14	.0122	.0122	.0125	.0079	.0049	.0087	.0151	.0140	.0238
15-19			.0055	.0098	.0062	.0183	.0086	.0071	.0175
20-24			.0064	.0056	.0112	.0053	.0096	.0154	.0043
25-49	.0231	.0165	.0280	.0367	.0284	.0287	.0217	.0434	.0384
50+	.601	.592	.614	.560	.543	.412	.468	.405	.372

LABOR FORCE SIZE (MEN)	YEAR 1957	1958	1959	1960	1961	1962	1963	1964	1965
1-4	.0455	.0511	.0542	.0642	.0695	.0671	.0569	.0514	.0514
5-9	.0296	.0365	.0423	.0445	.0605	.0615	.0532	.0498	.0508
10-14	.0237	.0212	.0299	.0357	.0337	.0389			
15-19	.0173	.0174	.0174	.0124	.0216	.0121			
20-24	.0107	.0075	.0155	.0080	.0034	.0179			
25-49	.0216	.0191	.0128	.0385	.0190	.0312			
50+	.353	.338	.284	.206	.184	.165	.152	.148	.169

Table A-21: Fatality rates per million man-hours in mines with one to nine, and 25 or more, workers, and ratio of fatality rates, 1948-1962.

(1) YEAR	(2) FATALITY RATE IN MINES OF SIZE 1 TO 9	(3) FATALITY RATE IN MINES OF SIZE 25 AND OVER	(4) (3)/(2)
1948	3.37	1.16	.34
1949	2.48	.90	.36
1950	4.57	.86	.19
1951	2.44	1.17	.48
1952	1.95	.88	.45
1953	2.35	.83	.35
1954	2.66	.97	.36
1955	2.50	.91	.36
1956	2.26	1.09	.44
1957	2.35	1.11	.47
1958	3.34	1.10	.33
1959	1.65	.82	.49
1960	2.34	1.11	.48
1961	2.53	1.18	.46
1962	1.85	1.18	.64

Table A-22: Fatality rates per million tons in mines with one to nine, and 25 or more, workers, and ratio of fatality rates, 1948-1962.

(1) YEAR	(2) FATALITY RATE IN MINES OF SIZE 1 TO 9	(3) FATALITY RATE IN MINES OF SIZE 25 AND OVER	(4) (3)/(2)
1948	5.98	1.68	.28
1949	4.41	1.28	.29
1950	7.52	1.14	.15
1951	3.86	1.46	.38
1952	3.12	1.24	.40
1953	3.61	.91	.25
1954	3.89	.94	.24
1955	3.24	.82	.25
1956	2.74	.87	.32
1957	2.64	.92	.35
1958	4.11	.85	.21
1959	1.89	.58	.31
1960	2.58	.74	.29
1961	2.89	.72	.25
1962	1.85	.68	.37

Table A-23: Non-fatal injury rate per million man-hours in mines with one to nine, and 25 or more, workers, and ratio of non-fatal injury rates, 1948-1962.

(1) YEAR	(2) NON-FATAL INJURY RATE IN MINES OF SIZE 1 TO 9	(3) NON-FATAL INJURY RATE IN MINES OF SIZE 25 AND OVER	(4) (3)/(2)
1948	45.15	59.70	1.32
1949	45.60	54.55	1.20
1950	46.39	50.05	1.08
1951	45.33	49.75	1.10
1952	44.17	50.42	1.14
1953	45.93	47.16	1.03
1954	47.13	45.52	.97
1955	34.88	47.18	1.35
1956	29.26	48.60	1.66
1957	38.74	48.29	1.25
1958	37.83	47.56	1.25
1959	37.11	44.53	1.20
1960	40.41	46.02	1.14
1961	42.47	48.17	1.13
1962	42.68	50.11	1.17

Table A-24: Non-fatal injury rate per million tons in mines with one to nine, and 25 or more, workers, and ratio of non-fatal injury rates, 1948-1962.

(1) YEAR	(2) NON-FATAL INJURY RATE IN MINES OF SIZE 1 TO 9	(3) NON-FATAL INJURY RATE IN MINES OF SIZE 25 AND OVER	(4) (3)/(2)
1948	80.04	86.46	1.08
1949	80.93	77.50	.96
1950	76.31	66.27	.87
1951	71.67	62.04	.87
1952	70.61	71.61	1.01
1953	70.52	51.70	.73
1954	69.01	44.04	.64
1955	45.23	42.63	.94
1956	35.54	42.09	1.18
1957	43.61	39.90	.92
1958	46.62	36.62	.79
1959	42.46	31.69	.75
1960	44.72	30.73	.69
1961	48.48	29.30	.60
1962	42.78	28.89	.68

Table A-25: Number of fatal injuries by regulated and unregulated category, and ratio of regulated to unregulated fatalities, 1943-1965.

(1) YEAR	(2) NUMBER OF FATALITIES IN REGULATED CATEGORY	(3) NUMBER OF FATALITIES IN UNREGULATED CATEGORY	(4) (2)/(3)
1943	199	931	.214
1944	56	959	.058
1945	92	739	.124
1946	44	667	.066
1947	174	720	.242
1948	63	698	.090
1949	13	412	.032
1950	14	455	.031
1951	171	447	.383
1952	21	368	.057
1953	21	328	.064
1954	28	263	.106
1955	17	286	.059
1956	19	323	.059
1957	82	293	.280
1958	55	234	.235
1959	17	193	.088
1960	21	225	.093
1961	38	204	.186
1962	58	168	.345
1963	34	184	.185
1964	8	180	.044
1965	19	196	.097

Table A-26: Number of non-fatal injuries by regulated and unregulated category, and ratio of regulated to unregulated non-fatal injuries, 1943-1965.

(1) YEAR	(2) NUMBER OF NON-FATAL INJURIES IN REGULATED CATEGORY	(3) NUMBER OF NON-FATAL INJURIES IN UNREGULATED CATEGORY	(4) (2)/(3)
1943	1062	43973	.024
1944	1215	43018	.028
1945	1226	38241	.032
1946	1068	35356	.030
1947	1238	37920	.033
1948	1126	34111	.033
1949	733	22472	.033
1950	706	23105	.031
1951	752	22817	.033
1952	680	19349	.035
1953	562	16349	.034
1954	430	11681	.037
1955	481	12806	.038
1956	516	13129	.039
1957	512	12580	.041
1958	412	9378	.044
1959	311	8164	.038
1960	330	8014	.041
1961	337	7538	.045
1962	337	7471	.045
1963	330	7420	.044
1964	324	7393	.044
1965	319	7632	.042

Table A-27: Size distribution of mines in Bell County, Kentucky, 1963-1974.

LABOR FORCE SIZE (MEN)	YEAR 1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1-5	53	39	28	23	18	10	13	6	10	3	6	3
6-10	34	43	24	25	14	14	6	7	6	8	8	5
11	3	0	1	0	1	1	1	0	0	0	1	1
12	6	3	7	2	1	0	0	1	1	0	1	0
13	0	0	0	0	0	0	0	2	0	1	0	0
14	1	3	2	0	1	0	0	0	0	0	1	1
15	1	0	0	2	0	2	0	0	0	0	0	0
16	1	0	0	1	1	0	0	0	0	0	0	0
17	2	0	0	1	0	0	1	0	2	0	1	0
18-20	2	1	2	2	1	3	1	1	1	1	2	1
21-25	1	3	3	3	4	0	2	2	1	3	3	4
26-75	4	7	4	7	10	9	5	4	6	3	2	6
76+	0	0	0	0	0	1	0	1	0	1	1	0
SMALL MINES	97	88	62	50	35	25	20	16	17	12	17	10
LARGE MINES	11	11	9	16	16	15	9	8	10	8	9	11

Table A-28: Size distribution of mines in Floyd County, Kentucky, 1963-1974.

LABOR FORCE SIZE (MEN)	YEAR 1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1-5	186	206	193	158	129	134	113	105	82	53	45	28
6-10	61	61	61	58	44	33	33	57	90	61	60	66
11	0	1	5	0	2	0	1	0	1	1	0	1
12	7	3	3	0	1	3	1	5	0	3	3	3
13	0	0	1	0	0	0	1	0	2	1	1	2
14	0	1	0	0	0	0	1	1	0	2	5	6
15	1	0	0	1	0	0	0	1	1	0	0	0
16	1	0	1	0	0	0	0	0	0	2	0	3
17	1	0	0	0	1	1	0	0	0	1	2	1
18-20	1	2	0	0	0	2	0	1	0	3	2	3
21-25	2	1	1	0	2	2	0	4	0	2	0	2
26-75	1	5	3	5	3	4	6	6	5	7	4	2
76+	9	6	9	7	7	5	5	3	3	4	0	1
SMALL MINES	254	272	263	216	176	170	150	168	175	121	114	106
LARGE MINES	16	14	14	13	13	14	11	15	9	19	8	9

Table A-29: Size distribution of mines in Harlan County, Kentucky, 1963-1974.

LABOR FORCE SIZE (MEN)	YEAR 1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1-5	53	80	69	49	47	47	46	37	23	27	19	24
6-10	53	33	34	34	23	19	23	22	16	13	10	15
11	10	2	3	2	3	1	1	4	1	3	0	1
12	7	8	3	5	4	4	3	3	2	4	4	4
13	2	2	2	2	1	5	1	2	3	1	0	3
14	5	6	1	2	0	1	1	2	0	4	2	3
15	3	2	3	1	0	0	2	3	7	2	0	3
16	3	3	4	2	3	1	1	2	3	2	1	2
17	0	1	0	2	2	1	0	2	3	0	1	1
18-20	7	5	3	3	4	3	6	2	3	3	6	3
21-25	3	7	6	4	7	6	6	7	5	1	7	7
26-75	17	17	13	11	9	12	11	13	11	16	20	22
76+	7	5	4	6	6	6	7	7	9	10	10	9
SMALL MINES	130	131	112	94	78	77	80	70	45	52	35	50
LARGE MINES	40	40	33	29	31	29	33	36	42	34	45	47

Table A-30: Size distribution of mines in Letcher County, Kentucky, 1963-1974.

LABOR FORCE SIZE (MEN)	YEAR 1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1-5	167	166	137	119	104	107	100	81	66	44	29	59
6-10	78	89	75	77	67	48	38	48	55	42	29	53
11	3	4	2	2	3	4	1	3	4	1	1	0
12	8	5	4	6	3	4	6	3	1	0	3	0
13	3	5	2	2	3	3	2	1	0	2	2	0
14	3	5	2	4	6	5	6	2	0	1	0	2
15	3	3	5	4	4	1	1	2	0	0	0	0
16	3	3	1	0	2	3	1	0	0	0	0	1
17	4	4	3	2	2	1	0	1	0	0	0	0
18-20	2	1	3	3	2	1	2	2	3	1	2	0
21-25	2	3	1	2	2	1	0	0	1	2	4	4
26-75	5	3	6	4	1	2	3	1	3	4	2	3
76+	5	5	5	7	7	5	5	5	5	4	5	4
SMALL MINES	262	274	222	210	186	171	153	138	126	90	64	114
LARGE MINES	24	22	24	22	20	14	12	11	12	11	13	12

Table A-31: Size distribution of mines in Pike County, Kentucky, 1963-1974.

LABOR FORCE SIZE (MEN)	YEAR 1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1-5	276	264	237	212	195	137	153	164	109	79	49	88
6-10	296	330	293	226	214	221	190	221	197	146	120	135
11	13	8	8	6	8	8	9	9	8	8	8	17
12	13	25	22	22	11	8	11	18	18	19	6	10
13	8	6	1	6	4	1	4	3	2	7	3	5
14	9	11	10	10	4	6	7	9	7	5	1	2
15	3	4	5	10	3	6	2	3	5	3	2	8
16	6	7	3	2	10	1	6	2	2	6	2	3
17	3	1	1	1	5	1	1	3	2	1	1	2
18-20	10	14	11	11	7	10	10	6	5	4	6	4
21-25	7	5	8	9	8	11	4	7	9	6	6	11
26-75	8	10	8	7	12	10	15	16	14	20	22	21
76+	5	4	5	6	8	10	10	10	11	9	9	12
SMALL MINES	615	644	571	482	436	381	374	424	341	264	187	257
LARGE MINES	42	45	41	46	53	49	48	47	48	49	48	61

Table A-32: Size distribution of mines in Ohio, 1961-1974.

LABOR FORCE SIZE (MEN)	YEAR 1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1-5	49	52	50	48	47	49	26	22	17	12	7	1	1	1
6-10	26	31	22	22	16	23	15	13	8	5	2	3	0	1
11	4	4	6	3	3	3	0	0	0	1	1	0	1	0
12	5	1	2	2	3	2	2	0	2	1	0	0	0	0
13	3	1	1	5	0	0	2	1	1	2	1	1	1	1
14	0	3	1	1	4	2	1	0	0	0	1	0	0	0
15	3	4	3	4	2	0	1	0	0	0	0	0	0	0
16	1	2	2	0	1	2	0	0	0	0	0	0	1	0
17	2	0	1	1	1	1	0	0	0	0	0	1	0	0
18-20	3	3	1	1	1	4	4	3	0	0	2	0	0	0
21-25	2	3	5	1	1	2	0	1	2	1	0	1	0	1
26-75	8	5	4	5	5	5	5	3	2	0	4	3	3	1
76+	9	12	11	9	9	10	11	13	12	15	16	18	17	20
SMALL MINES	87	92	82	81	73	79	46	36	28	21	12	5	3	3
LARGE MINES	28	29	27	21	20	24	21	20	16	16	22	23	21	22

Table A-33: Size distribution of mines
in Alabama, 1964-65 to 1973-74.

LABOR FORCE SIZE (MEN)	YEAR 1964-65	65-66	66-67	67-68	68-69	69-70	70-71	71-72	72-73	73-74
1-5	57	48	32	24	26	19	5	1	5	4
6-10	75	66	28	34	28	13	8	9	2	2
11	5	4	2	3	0	2	0	0	0	0
12	7	4	6	6	4	1	0	0	0	0
13	7	5	2	5	0	1	1	0	0	0
14	11	10	4	0	1	0	0	0	0	0
15	5	5	3	2	1	1	1	0	0	0
16	1	1	2	0	2	0	1	0	1	1
17	2	1	0	1	1	0	0	0	0	0
18-20	4	6	3	1	1	2	0	0	0	0
21-25	2	2	5	1	1	0	1	0	0	1
26+	13	14	12	12	13	13	11	13	13	13
SMALL MINES	162	137	74	72	59	36	14	10	7	6
LARGE MINES	27	29	25	17	19	16	14	13	14	15

Table A-34: Size distribution of mines in West Virginia, 1962-1973.

YEAR	LARGE MINES	SMALL MINES
1962	204	753
1963	222	858
1964	219	797
1965	230	773
1966	223	684
1967	206	543
1968	207	481
1969	206	406
1970	224	306
1971	234	226
1972	276	131
1973	256	121