Chapter 7

SEARCHING FOR CAUSES

The previous two chapters presented information on the two major objectives of this study. Chapter 5 examined whether specific actions by government enforcement agencies, companies and unions had succeeded in reducing radiation levels in uranium mines. Chapter 6 looked at the events and historical dynamics which aroused concern among those in a position to do something. It was shown that a stepped up program of inspections by government enforcement agencies and increased ventilation expenditures by companies coincided with dramatic declines in the level of radiation in mines. In turn, factors such as waning demand for uranium, increased visibility of the hazard, stabilization of the industry and new high-level official policies seemed linked to the government and company actions. These trends are summarized in the following figure. (See Figure 9)

Correlation coefficients between the variables representing these trends were computed and were generally very high. The strengths of association between the variables are summarized in Table 36.

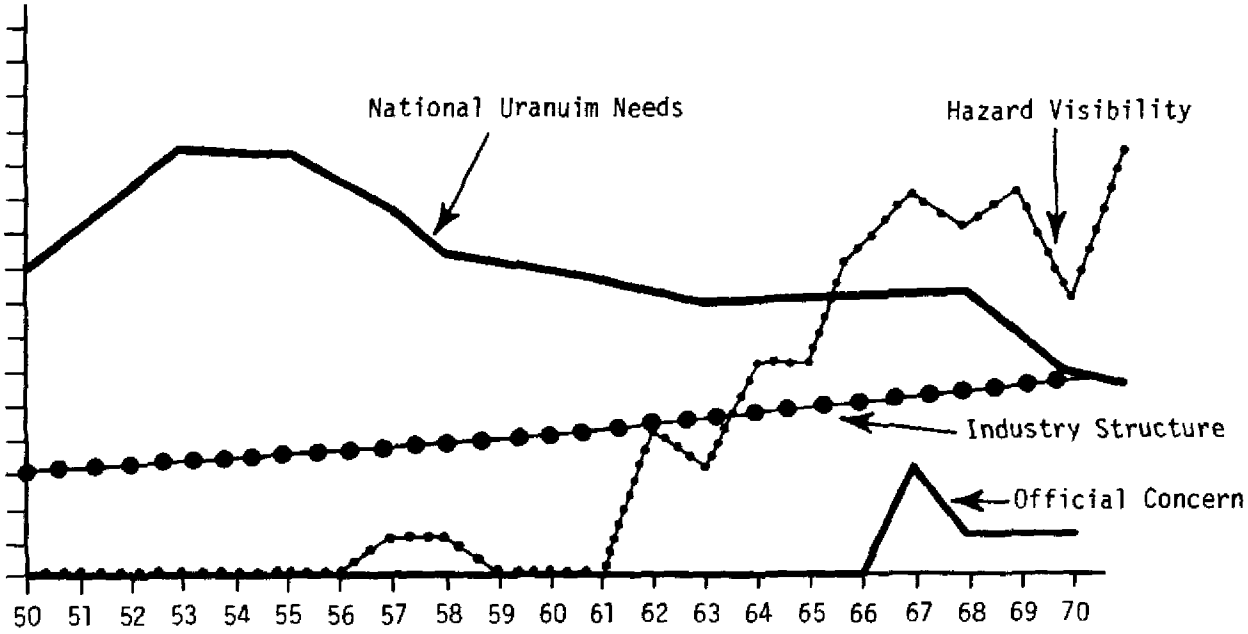
Correlation, however, is no proof of causation. Moreover, the model has not identified which historical factors, if any, were more responsible than others for the onset of organizational concern. Nor has it differentiated between respective influences of government and company concern on radiation. (See Figure 10)

At this point, the model, on the basis of the analysis presented in Chapters 5 and 6, singles out certain historical factors as "prime movers" and others as consequences. Among the concern variables, the influence of government and company actions on radiation will be distinguished.

Logically, it seemed plausible to hypothesize that national uranium needs and the tide of compensation claims filed by afflicted miners and their families touched off the process that eventually culminated in the reduction of hazardous radiation in mines. Both factors reflect financial considerations which are presumed to be critical in decision-making in industrial societies such as ours. Moreover, it seemed likely that company expenditures for ventilation were directly responsible for reduced levels of mine radiation, but that such expenditures followed only in the wake of relentless government regulatory activities. This hypothesis is supported by the work of Ralph Nader, Kohlmeier and others showing the need for watchdog agencies to supervise industry in order to solve a variety of consumer ills.[119]

Figure 9

Trends in Historical Factors, Organizational Concern and Worker Health, 1950-1970



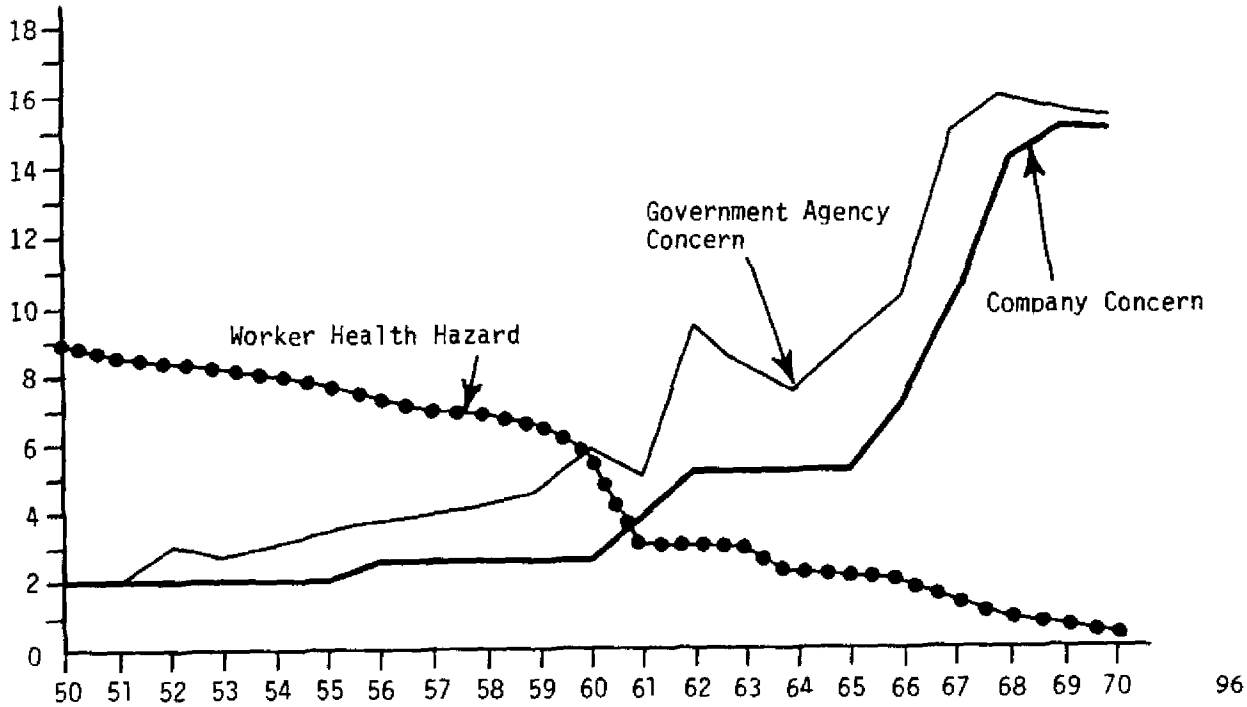


Table 36

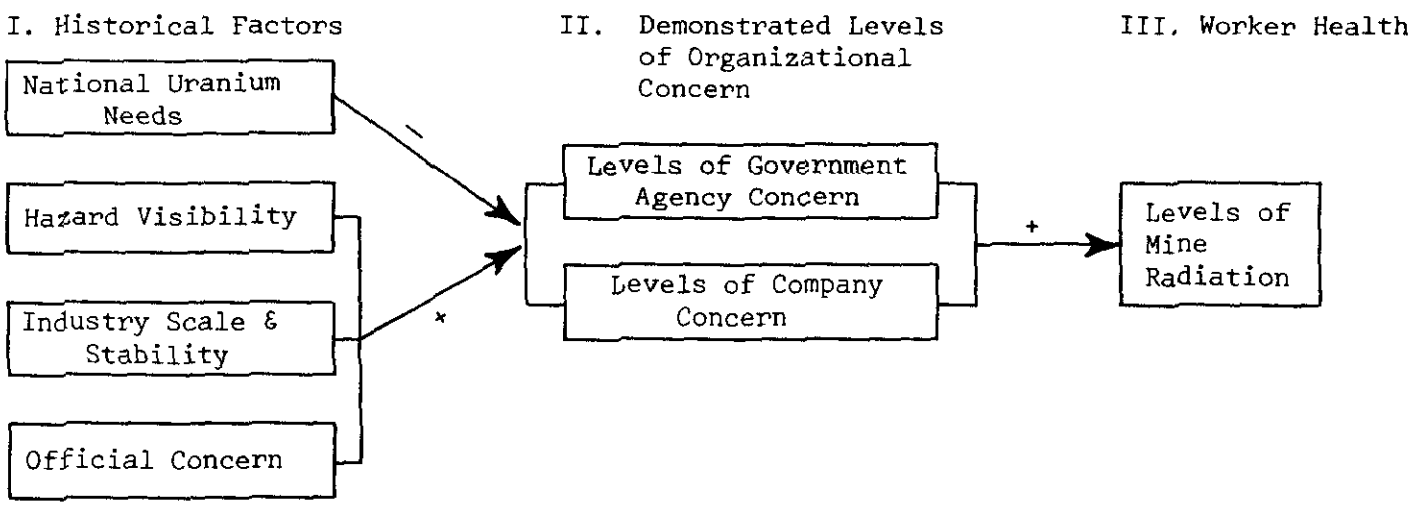
Correlations Between Historical Factors, Organizational Concern Variables and Radiation Levels in Mines, 1949-1970

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. National uranium needs (dollars per ton ore)[a]	1.00						
2. Hazard visibility (numbers of compensation cases per year)[a]	-0.696	1.00					
3. Industry scale and stability (percentage of mines owned by Union Carbide Corp.)[a]	-0.796	0.916	1.00				
4. Official concern (numbers of bills introduced to Congress on the hazard per year)[a]	-0.345	0.679	0.546	1.00			
5. Government agency concern (numbers of inspections of uranium mines each year)[b]	-0.747	0.945	0.959	0.647	1.00		
6. Company concern (dollars expended per ton of uranium for ventilation each year)[c]	-0.683	0.922	0.888	0.617	0.915	1.00	
7. Radiation levels (mean radiation levels in U.S. uranium mines per year)[d]	-0.849	-0.786	-0.950	-0.430	-0.879	-0.757	1.00

[a]Information assembled at time point #1, e.g., 1949, 1950, 1951
[b]Information assembled at time point #2, e.g., 1950, 1951, 1952
[c]Information assembled at time point #3, e.g., 1951, 1952, 1953
[d]Information assembled at time point #4, e.g., 1952, 1953, 1954

Figure 10

A Model of the Process of Solving the Hazard of Excess Radiation in Mines



The revised model of the problem-solving process is presented in Figure 11. As is readily visible, it underscores the importance of national uranium needs and mounting evidence of a serious health hazard. Both these variables are presumed to be causally unrelated to one another. Hazard visibility was a simple product of the passage of time. As time elapsed, lung cancers developed among uranium miners and mounting numbers of compensation claims were filed. Variations in the national need for uranium, on the other hand, were due to fluctuations in the supply of ore and the nation's concern with atomic weaponry. As uranium reserves grew and the cold war climate of the late 1940's and early 1950's slackened, demand tapered.

The other two historical factors, industry structure and official concern, are represented as causally dependent upon national uranium needs and visibility factors. The structure of the industry changed with declining demands for the ore. Declining demand caused the subsidies, incentives and bonuses extended by the government to uranium producers to be withdrawn, in turn causing small operators to leave the industry and only large companies to stay. The result was a stable, mature, large-scale industry. Official concern, measured in terms of the annual number of bills introduced into Congress concerning radiation in mines, on the other hand, was a byproduct of the visibility of the hazard. As compensation claims filed by miners multiplied, the attention of legislators and federal officials was aroused.

The next step in the chain is the demonstration of concern by the government enforcement agency. It is represented as a product of official concern. Charged with a mandate from federal agencies to solve the problem of excess radiation, local caretaking agencies embarked on a control program of inspections and sanctions.

Government agency concern, in turn, directly influenced the expenditures made by mining companies for ventilation. Faced with frequent inspections and costly sanctions, companies increased their outlays for ventilation. This was abetted by the transformation of the industry to a large-scale and stable one. Stable operators were more able financially to install fans and other ventilation equipment than the transient speculators that had mined uranium in the early days of the industry.

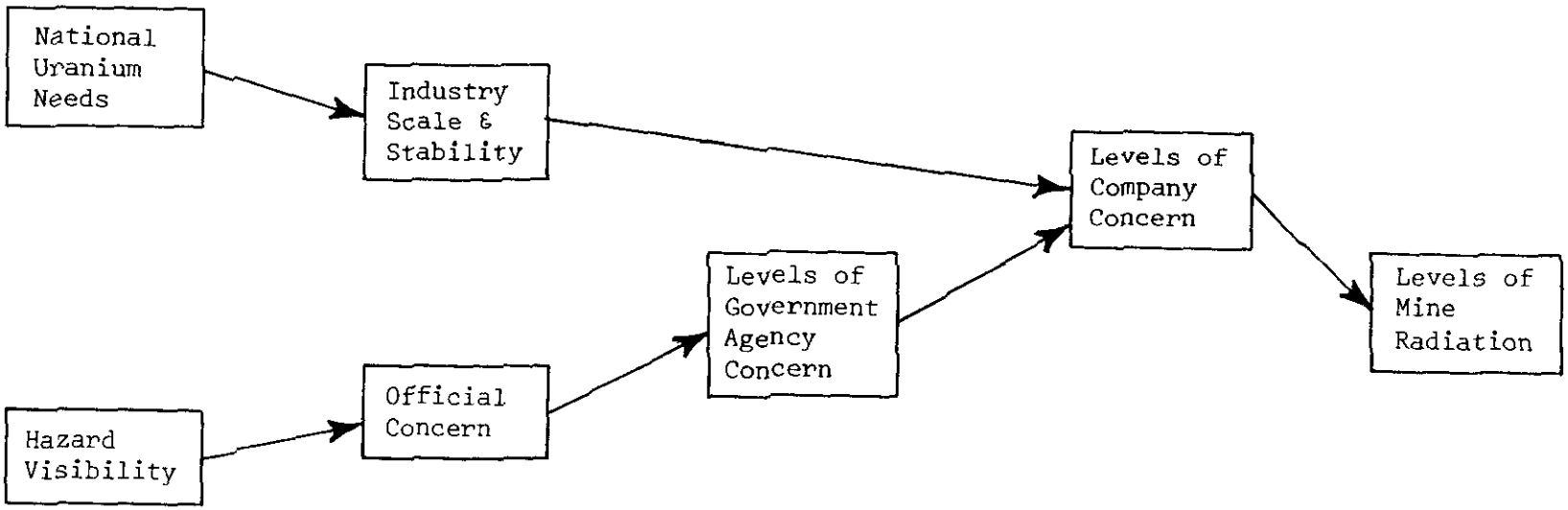
At last, increased company expenditures, a byproduct of vigorous government regulations and the changed structure of the uranium mining industry, reduced radiation levels in mines.

USING PATH ANALYSIS

To test the efficacy of this model, statistical techniques were needed which would permit causal inference. One such technique is path analysis. It amounts to a series of multiple regressions sensitive to the direct and indirect influence of variables on each other.

Figure 11

A Revised Model of the Process of Solving the Hazard of Excess Radiation in Mines



In addition, it takes account of all other influences on the variables in question, e.g., causes not recognized or measured, errors of measurement, and violations of assumptions basic to the technique. As Duncan puts it,

> An important feature of this kind of causal scheme is that variables recognized as effects of certain antecedent factors may, in turn, serve as causes for subsequent variables. For example, U is caused by V and X, but it in turn influences W and Y. The algebraic representation of the scheme is a system of equations, rather than the single equation more often employed in multiple regression analysis. This feature permits a flexible conceptualization of the modus operandi of the causal network. (120)

In order to use this technique properly, however, certain assumptions must be met. (121) The procedure requires a set of variables which have been measured on an interval scale. These variables are assumed to be related to one another in a linear, additive fashion. Certain variables are presented as linear functions of others. These are dependent variables. The remaining variables are assumed to be given and termed "independent." Each "dependent" variable must be regarded explicitly as "completely determined by some combination of variables in the system." Where such complete determination is absent, a residual variable must be introduced which is itself uncorrelated with any relevant, independent variable. In other words, it is assumed that there is no variable external to the model which is simultaneously affecting any two variables in the model causing a spurious correlation.

The technique of path analysis also requires one way causation among variables; feedback effects are not tolerated. Variables in a path model are assumed to have equal variances (homoscedasticity), and dependent variables in a path model are presumed to be uncorrelated with one another, or only weakly so (low multicollinearity).

The problems with path analysis in this study relate almost entirely to the assumptions of low multicollinearity. As Table 35 shows, the several measures of organizational concern and the measure of radiation levels are substantially intercorrelated with one another; the same intercorrelation prevails between the independent "historical" variables.

There are at least two reasons why. Since the information used in deriving the correlation matrix was obtained from various annual directories, it was aggregated and averaged. There is a possibility that such aggregation compromised the independence of various variable measures and produced elevated correlation coefficients. On the other hand, aggregate information and yearly means have been applied in path analytic models. In and of itself, such information should not lead to high interdependence. A second explanation is the intrinsic interrelatedness of the phenomenon at hand. Changing needs for uranium, the visibility of the hazard; the structure of the industry and government

policies tracked closely with the onset of organizational concern. In turn, such concern was associated with declines in mine radiation. Given such a state of affairs, high intercorrelations are understandable. The problem may lie with the multiple regression technique itself. It is unable to handle highly interrelated phenomenon.

In any event, the high correlations among dependent variables obtained in this study do violate an assumption of the analysis. On the one hand, "the value of using path analysis may be seriously undermined if ...(its) basic assumptions are violated substantially;"[122] on the other hand there seems to be no necessity for each assumption to be met without deviation. The analysis will proceed despite the problems of multicollinearity regarding all results with healthy skepticism. The aim is not to test a causal model, but to suggest a chain of causality supported by the evidence at hand.

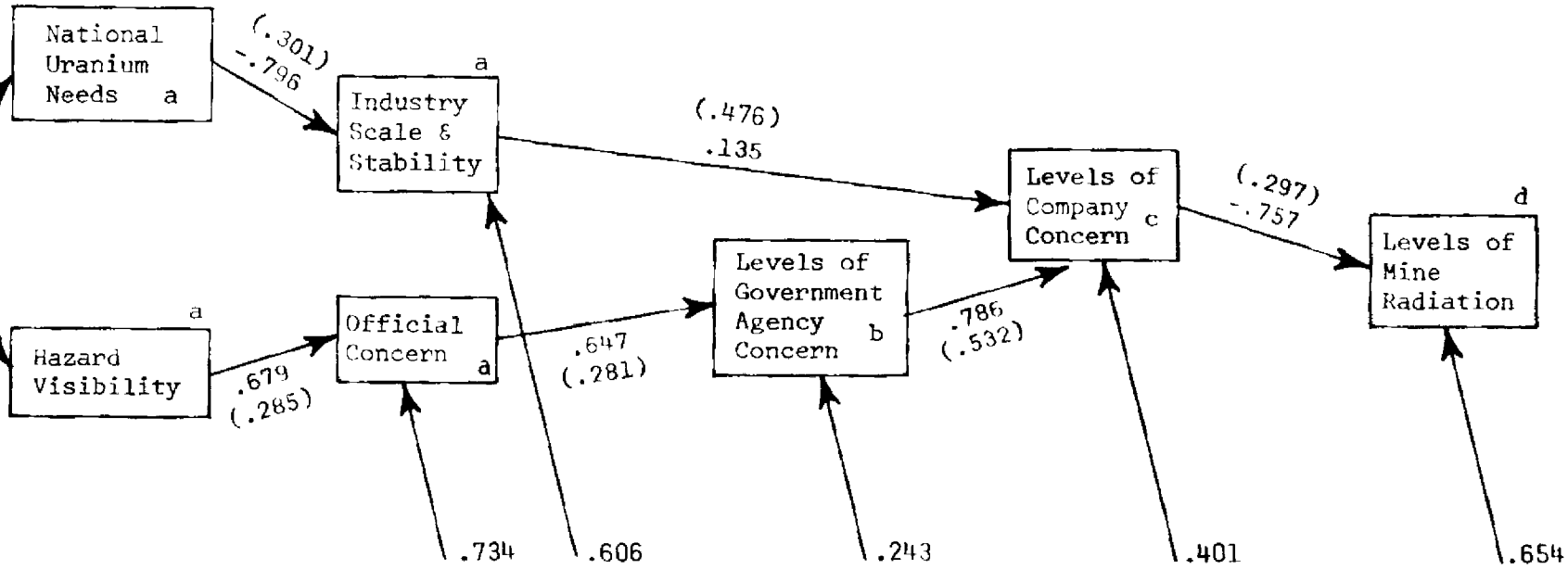
It should be noted that other assumptions of path analysis have been largely met in this study. All variables have been measured in terms of an interval scale; none is ordinal or nominal. Scatter diagrams and graphs of the project variables suggest that the assumptions of linearity and homoscedasticity are fairly well met. To the extent that a thorough historical search can be relied upon, it here uncovered no variable external to the model capable of causing a spurious correlation; thus the assumption of residuals uncorrelated with any independent variable seems to have been met. To meet the assumption of one way causation, a slightly different technique was used. The information collected for each variable was keyed to that variable's respective temporal role in the hypothesized chain of causation. Thus, data for the historical factors (national uranium needs, hazard visibility, industry structure and official policy) relate to the earlier time period, e.g., year one. Measurements of organizational concern were drawn from an intermediate time period, e.g., year two. Radiation information relates to the latest time period, e.g., year three. Since the total time period covered in this analysis is only twenty years, however, such staggering of the variable measures does reduce the number of "observations."

REVISING THE MODEL

To test the efficacy of the model presented in Figure 11, path coefficients were computed for all hypothesized relationships. The coefficients and standard errors associated with each relationship are presented in Figure 12. In most cases, the derived coefficient is greater than twice its standard error. This indicates that the coefficients are significantly different from zero. The exceptions to this are the paths leading from "Industry Scale and Stability" to "Levels of Company Concern" and from "Levels of Government Agency Concern" to

Figure 12

Path Model I of the Process of Solving the Hazard of Excess Radiation in Mines



Standardized Regression Coefficients
and
(Standard Errors)

* Information conbined from four different time points. "Historical Variables" (a) assembled at time point #1 (e.g., 1949, 1950...); Government Concern (b) at time point #2 (e.g., 1950, 1951...); Company Concern (c) at time point #3 (e.g., 1951, 1952...); and Radiation Levels (d) at time point #4 (1952,1953).

"Levels of Company Concern." The former path has a coefficient of 0.135 and a standard error of 0.476. In the latter case, the path is 0.786 and the standard error is 0.532. This suggests that the scale and stability of the industry was not an important factor in the generation of concern among companies mining uranium. Since the path coefficient between government agency concern and company concern was large, it was decided to alter the model to enhance the role of the government agency. It was postulated that the demonstration of concern by the government enforcement agency was a product of both official concern and industry scale and stability. The transformation of the industry to a large scale and stable one aided the program of government inspections and sanctions since stable operators were more readily supervised than the transient speculators that had mined uranium in the early days of the industry. The model was revised accordingly and path coefficients were recomputed. See Figure 13.

The revised model appears to handle the process of reducing radiation somewhat better. Paths between "Industry Scale and Structure," "Levels of Government Agency Concern" and "Levels of Company Concern" are both strong and significantly different from zero. The expenditures of mining companies for ventilation, thus, may be attributed solely to the activities of the government enforcement agency.

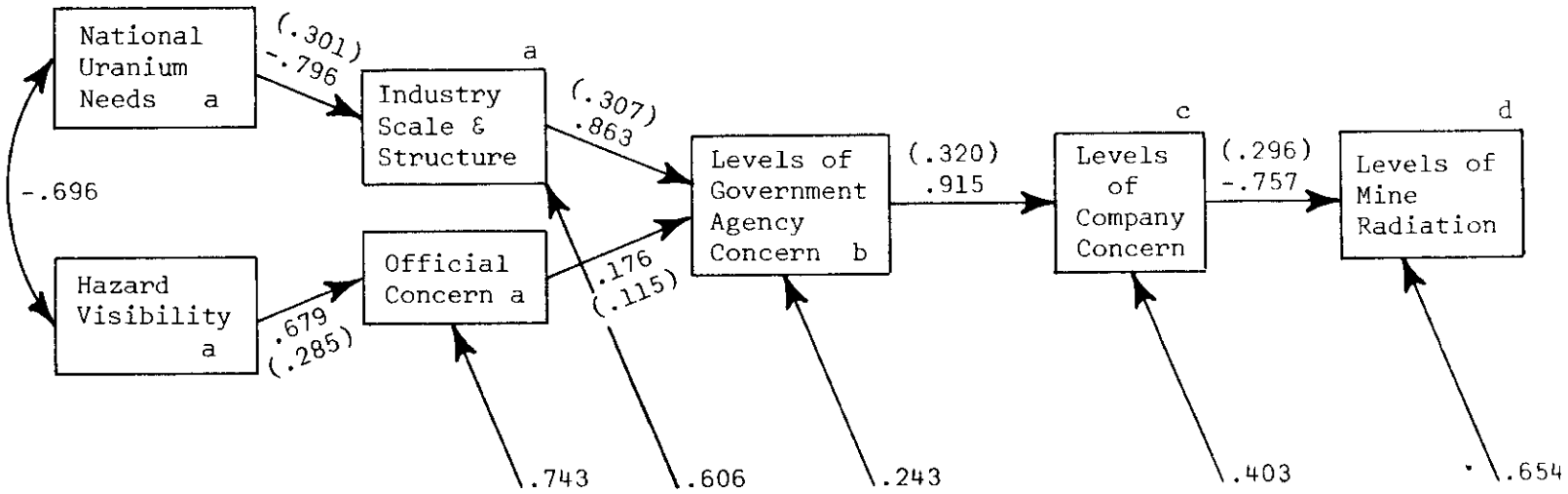
The path leading from "Official Concern" to "Levels of Government Agency Concern," however, is not significant. It has a coefficient of 0.176 and a standard error of 0.115. This suggests that the attention of federal officials and legislators was not critical in the initiation of inspection activities by the state enforcement agency. This conclusion is consistent with an analysis of the correlation coefficients between the variables representing historical factors and government agency concern. (See Table 35) While the correlation coefficients between national uranium needs, hazard visibility, industry scale and stability and government agency concern were -0.747, 0.945 and 0.959, respectively, the coefficient between official concern and government agency concern was 0.647.

In light of this finding, the model was once again revised. This time, "Official Concern" was excluded. Instead, it was postulated that evidence of the hazard itself directly influenced regulatory activities by the government agency. (Hazard Visibility $\longrightarrow$ Levels of Government Agency Concern.) All path coefficients were recomputed for the new set of postulated relationships. They are presented in Figure 14.

The revision appears to be warranted. Although the coefficient for the path between Hazard Visibility and Levels of Government Agency Concern falls below the level required for statistical significance, (coefficient = -0.417, standard error = -.240; requisite coefficient for significance =0.480), it is only slightly below. All other paths of influence postulated in the model are strong and significantly different from zero.

Figure 13

Path Model II of the Process of Solving the Hazard of Excess Radiation in Mines

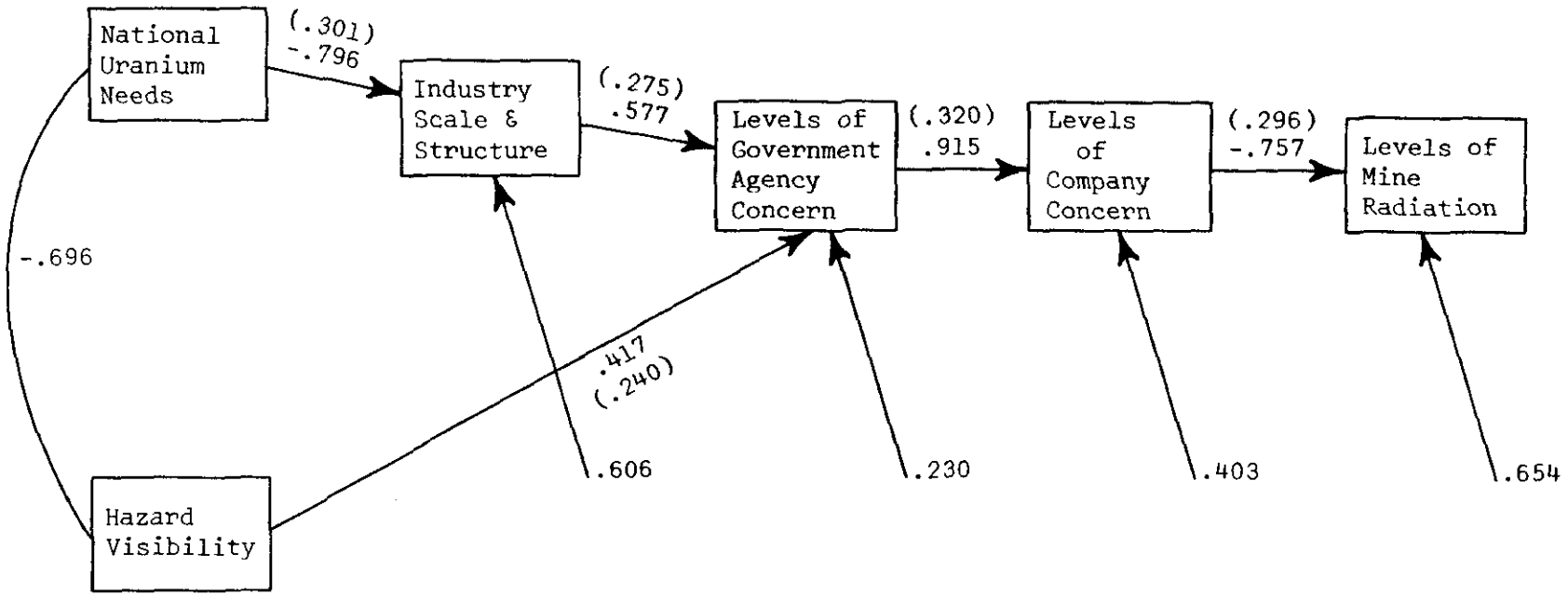


Standardized Regression Coefficients
and
(Standard Errors)

* Information combined from four different time points. "Historical Variables" (a) assembled at time point #1 (e.g., 1949, 1950, 1951...); Government Concern (b) at time point #2 (e.g., 1950, 1951, 1952...); Company Concern (c) at time point #3 (e.g., 1951, 1952, 1953...); and Radiation Levels at time point #4 (e.g., 1952, 1953, 1954...).

Figure 14

Modified Path Model of the Process of Solving the Hazard of Excess Radiation in Mines



Standardized Regression Coefficients
and
(Standard Errors)

Thus, the reduction of radiation in mines directly depended upon the expenditures mining companies made for ventilation equipment. Such expenditures were themselves a product of the increased vigilance of the government enforcement agency. Government inspections increased as the industry changed from a speculative one composed of transient operators to one composed of stable, large-scale companies. At the same time, this transformation was itself a product of changing levels of demand for uranium ore. Government inspections also depended upon the visibility of the hazard. As greater numbers of compensation claims were filed by afflicted miners and their families, the volume of regulatory activities surged.

Chapter 8

CONCLUSIONS

SUMMARY

This has been a case study of the organizational actions which ultimately solved an industrial health hazard. It has shown that the greatest reductions in hazardous radiation in mines followed inspection and sanction activities by a state enforcement agency. Continual surveillance by government agents and the imposition of costly penalties against operators who violated radiation codes led companies to invest the necessary capital for equipment capable of reducing underground radiation.

It has also been shown that a variety of non-technological barriers prevented an early solution of the problem. National needs for uranium ore, the invisibility of the radiation hazard and the unstable and transient nature of the early uranium mining industry all distracted attention from the damaging effects of radiation. When needs were great; the industry transient and small-scale; and the tangible results of bodily exposure to radiation invisible; the regulatory activities of those in a position to do something about the hazard were modest. As demands for the ore waned; as the industry became more large-scale and stable; and as lung cancer damage to miners began to make itself felt through deaths and compensation claims; the government adopted steps to stem the tide of death and disease, including a stepped-up program of inspections and sanctions.

POLICY IMPLICATIONS

More than 12,500[123] people are annually killed in accidents that are job-related and an additional 2.2 million[123] suffer temporary disabling injuries in the course of their job activities. Untold numbers suffer deteriorating health as a result of harmful work environments. It is estimated that 100,000 lives are claimed annually by work-related disease.[124] Frequently, such diseases do not explode until many years after exposure to harmful materials on the job. Recent evidence on occupational disease also suggests that health imperilment goes beyond the worker himself. The wives and children of asbestos workers, as well as anyone who works in the general vicinity of asbestos, for

example, share elevated risks of mesolothelioma, stomach and lung cancer.[125]

Logically, the problems of industrial injury and industrial disease are distinct. On the job exposure to toxic materials like radiation, beryllium, and lead often occurs without any knowledge on the part of the worker that it is occurring. The harmful effects of such exposure are slow to manifest themselves and the worker frequently becomes aware of an industrial pathology only when it is irreversible. Nor does the worker know that the contamination can often be controlled with technology or innovative work procedure. The prevention of industrial accidents, on the other hand, is occasionally within the realm of the worker's control. On-the-job injury may sometimes be caused by his own carelessness. Unlike the worker who inhales unknown chemicals, the worker who engages in foolish and slipshod behaviors is or should be aware of the possible consequences.

Despite the logical distinction between industrial injury and industrial disease, a similar psychological framework has been adopted to explain the incidence of both.[126] In recent years, during which there has occurred the first recognition of occupational diseases, the long tradition of blaming the worker himself for on-the-job accidents has been generalized to the case of on-the-job diseases. The upshot has been that the causes of both industrial diseases and industrial accidents have been frequently attributed to the actions of the worker who becomes a victim. This psychological orientation to the problems of industrial disease and accidents has received additional support from some social scientists.

Numerous studies of miners blame the exceptionally high accident rate in mining on the carelessness of miners on the job.[127] One writer sees miners as fatalistic, apathetic and anxious about their masculinity.[128] These traits, it is argued, lead them to reject safety equipment and to refuse to adopt prudent behavior. Another writer sees the rejection of safety equipment by miners as a denial of the truly threatening nature of their work environment.[129] The miner, the argument runs, is more psychologically comfortable if he denies the need for safety equipment than if he admits that his physical surroundings are dangerous by requesting and using such equipment. A social worker views the miner as a resigned, apathetic and willing victim.[130] And other refer to the miner's high degree of "external locus of control"[131] or fatalism as causing an unwillingness to consider the possibility of accidents.

Individual carelessness has also been held up as a cause of industrial diseases. In smelting and pottery-glazing industries, for example, disease was blamed on the worker's handling of food and chewing tobacco without first washing his hands. This prejudice persisted despite the documentation of dangers arising from the lead infused atmosphere.[132]

A similar investigation into the hazards of asbestos was conducted by the journalist, Paul Brodeur. He unearthed a general unwillingness on

the part of industry and government officials alike to associate conditions of the workplace, over which the individual worker exercised no control, with occupational disease, despite voluminous documentation of such an association. In response to Brodeur's questions concerning the connections between disease and exposure to asbestos fibers, for example, a medical consultant to the asbestos industry noted that cigarette smoking was a cause of asbestosis although available information indicates a limited effect of cigarette smoking on lung scarring.[133]

As has been seen, the tendency to blame the worker for occupational disease was also common in the uranium situation. Numerous respondents to interviews administered in 1973 persisted in stressing the importance of the smoking, drinking and eating habits of the uranium miner to explain his exceptionally high incidence of lung cancer. These arguments were offered many years after the Public Health Service had documented that "low living" could not be the cause of elevated rates of disease among the population that mined uranium.

According to the traditional point of view which considers both industrial accidents and diseases as caused by worker carelessness, the remedy for hazardous working environments lies in the education of the employee in safety procedures.[134] Thus, government and company efforts to improve the health and safety of the workplace frequently concentrate exclusively on safety training sessions, safety posters and safety slogans. Plants dealing with toxic materials post signs urging workers to wash their hands before eating. Many corporations give Green Stamps to workers with outstanding safety records. The extent of this mentality, albeit not in an industrial disease setting, is illustrated by the New York manufacturing plant that has adopted "Operation PIG" (Prevent Injury and Grime), whereby the department with the poorest safety record over a given period of time must take care of a live pig until some other department compiles a worse safety record and thus qualifies for custody of the pig. A department with an accident free record over a given period of time also wins a pig, but in the form of a roast pork dinner.[135]

Official, high-level policies on health and safety matters also tend to reflect this emphasis on individual carelessness. During the 1969 House Hearings on the Occupational Safety and Health Act, the President of the National Safety Council testified that

> ...with all due respect to the desirable effects that the promulgation and enforcement of standards can have on the nation's occupational health and safety performance, we must recognize that the successes that have been achieved so far are largely the result of the dissemination of safety information, the implementation of proven counter measures and education and training of employers and employees. (136)

A cornerstone of the new Occupational Safety and Health Act is the education of careless workers. Since it became law on December 29, 1970, the program has included a series of radio commercials, such as the following:

Grab a sack of safety, let it fill your bag,
Workin' where you're careless is a hurtin' drag, yeah,
Take a sec and check around your own two feet,
Then sing a song of safety...
It's a hap, happy beat, Yeah! (137)

The worker-carelessness argument, however, has a very shaky basis in reality. Some accidents are obviously causally related to the unsafe behavior of the worker. On the other hand, many others are undoubtedly caused by factors beyond the control of the worker: work procedures; equipment breakdowns; and unsafe practices by management. Moreover, industrial disease are generally caused by pollutants of which workers are ignorant altogether.

A Bureau of Mines survey of 270 accidents in 1961 concluded that 50.7% resulted from circumstances beyond the control of the individual but within the range of supervisory responsibility.[138] A similar study in the chemical industry concluded that only a slim minority of accidents (8%) could be attributed to human carelessness. On the other hand, 44% were due to faulty equipment and 40% to faulty methods of operation dictated by management.[139]

A study of British factory deaths caused by inadequate design of safety devices in machines has noted the legislative failure to enforce safety provisions for machine design. Although laws did exist specifying design requirements, the purchasing of machines was left to the discretion of individual factory management. It was found that cheaper and faster models with high sales appeal were frequently purchased at the expense of safety considerations.[140]

Even the world's most hazardous occupation is less dangerous in certain legislative and organizational climates.[141] A comparative study of mining accidents in Europe and America concluded that the system of private ownership and operation of American mines and the ensuing emphasis on profit and production was responsible for the extreme hazardousness of United States coal mining. The American coal mining industry is simultaneously the most productive and dangerous in the world. Its fatality rate between 1965 and 1969 was at least twice that of its European counterparts although the mines in Europe are deeper and inherently more dangerous. The differences appeared to stem from the often costly safety procedures adopted by the European industry and neglected in American mines. These include the Longwall technique of mining, sophisticated methods of detecting lethal gas and alerting endangered men, fire blockades and elaborate watering systems to reduce coal dust. As one scientist familiar with the United States and European coal mining industries has put it:

The difference is that while our management people are also striving for production and profit just as their counterparts are in the United States, the push to produce is not as hard and the punishments for violating safety standards are a bit swifter, so our people aren't as quick to break the law or endanger a man's life. (142)

It is in connection with the mounting evidence that worker injuries and diseases are beyond the control of the victim that the findings of this study are relevant. The reduction of hazardous radiation in mines, it was found, was due to the relentless inspection activities of government watchdog agencies. Faced with costly penalties for violating mandatory standards imposed by government agencies, mining companies made the necessary expenditures to implement ventilation equipment. As a result, radiation levels dropped and the health of the miner improved.

This study suggests that reduction of hazards beyond the control of workers can only come through strict government supervision of industry. To the extent that legislation designed to solve health and safety problems includes strong regulatory provisions, it promises to be effective in achieving the goal of safer work places. On the other hand, legislation which fails to establish strong regulatory mechanisms promises to be ineffective in reducing industrial health hazards. In this light, the new Occupational Safety and Health Act is disappointing. The Act provides no mechanisms for the mandatory and regular inspection of workplaces and where inspections do occur, the employer is notified in advance. In the first ten months of operation the Labor Department proposed penalties totalling $1,711,995 for 75,864 violations--an average proposed fine of $23 per violation.[143] If the predictions of this study are borne out, the Act as it is currently constituted will accomplish little in the way of achieving safer and healthier working conditions for the nation's labor force. Until and unless industry is relentlessly inspected and severely punished for violations of health and safety codes, hazards beyond the control of the worker will persist and the worker will continue to suffer.

GENERAL IMPLICATIONS

Although the study is a case study, and, as has been argued, has implications for policies that aim to improve the health and safety of workers on-the-job, it also has practical applicability to a large number of other substantive and theoretical concerns. Neither its findings nor its methodology and theoretical underpinnings are necessarily bounded by its substantive content.

First as to the general relevance of the theory and methodology underlying this study to the broader issue of how complex societies solve their problems. The basic approach and methodology used to examine the lung cancer epidemic among uranium miners went far beyond the specific factual parameters of the problem situation. Rather, both theoretical approach and methodology sought to portray the problem-solving process in terms of its two analytical stages, the goal-formulation and the goal-realization stage. Within each stage the model took account of a variety of general economic, political and legal factors; and in addition it took account of various

interorganizational influences which shape the behavior of organizational problem-solvers. The analytical constructs used in the process of developing a model of the problem-solving process stand on their own feet. Others can apply them to problem-solving situations involving (a) a particular societal problem (b) organizational actors and (c) historical and organizational pressures generated in the relevant societal climate.

As to the study's substantive relevance, a brief effort will be made to suggest how similar problem-solving dynamics are at work in numerous social problem areas other than uranium.

Trade imbalances, consumer shortages and financial crises are varieties of national needs with the potential to affect the process of problem-solving. The asbestos situation provides an obvious and analagous example.[144] There, the sluggishness that characterized government and industry response to the hazard of asbestos dust was in part due to the dependence of the national economy on critical asbestos products. e.g., insulation materials. There are currently no near substitutes for asbestos; in addition more than four million jobs in this country deal directly or indirectly with asbestos. National needs have also featured in recent moves to lower the permissible threshold on the sulfur content of coal that is burned in the atmosphere. Despite voluminous documentation of the detrimental effects of sulfur pollutants, the national fuel crisis distracted attention away from these humanitarian considerations.

Hazard visibility, which was shown to feature strongly in the decision to control underground levels of radiation, finds analogues in the casual use of X-rays, pesticides, sedatives and other drugs and chemicals which were or are used without restraint despite the warnings of a variety of scientists and consumer advocates.[145] Predictably, the promiscuous use of such materials tends to cease only in the wake of tragedies of major proportions: a series of hideous birth deformities; elevated mortality from radiation exposure; or the contamination of plant and animal life with toxic pollutants that ultimately make their way into the human food chain.

Industry structure has been also shown to feature in a variety of problem-solving situations other than uranium. Ralph Nader and his associates weight it heavily in their studies of consumer ills. Many economists, also, see industry structure as a determinant of price levels, inflation and product quality. Nader himself goes so far as to blame excessive corporate concentration and the attendant decline of competitive capitalism for polluted air and water.[146]

The languid pace in the formulation of official, upper-level policies concerning the radiation hazard characterizes a great number of problem situations. It characterizes so many in fact that Professor K. C. Davis has offered a legal scholars' argument in favor of abandoning any search for policy guidance for problem-solving from legislative bodies.[147] According to Davis, Congress has so typically and consistently failed or refused to specify standards when it delegates authority to administrative agencies that it no longer should be depended upon to do so. More effective

administration, says Davis, would be achieved by independent administrative agencies with court involvement in the elaboration of standards and administrative rules. In the uranium situation, where Congress neglected to initiate any legal action, Davis' diagnosis hits home.

THEORETICAL IMPLICATIONS

In addition to the utility of the problem-solving famework for other substantive issues, the study suggests a theory of problem-solving in complex societies. The central elements of the theory are so-called "historical" factors that feature in problem-solving and the impact of interorganizational influence on problem-solving.

First as to the role of "historical" factors. Sociological literature on complex organizations notes that a variety of technological, legal and economic factors affect problem-solving in its goal-formulation and goal-realization stages. None is singled out as particularly important. The findings of this study permit the observation that such factors are not equally important in problem-solving. For example, technology to handle the problem of excess radiation in mines was available throughout the problem-solving period. But technology did not play a critical role. The impact of official, upper-level government agencies was also extremely modest. This appears to cast some doubt on the importance of legal considerations in the problem-solving context.

What emerges from this study is the overriding significance of factors in problem-solving that can loosely be classified as "economic." National needs, the visibility of the hazard (measured in terms of compensation claims), and the structure of the industry all have had a primary bearing on profit and loss statements. National needs reflects the supply and demand picture for a product or service. Hazard visibility enters the balance sheet through the added costs to industry of compensating victims of an occupational hazard. Industry structure reflects the financial capability of firms and thus the ease with which they are able to withstand the costs of implementing equipment to reduce a hazard.

The problem-solving process bore the imprint of an economic calculus designed to minimize costs. Only when the demand for uranium fell, the number of compensation claims rose and the industry changed to one composed of wealthy, large-scale firms that could afford to provide effective ventilation equipment did the economic calculus yield to the health interests of the voiceless miners. The study provides a confirmation of the frequent observation that the interests of the unorganized come to the fore only when their ills are translated into monetary terms. It suggests that the varieties of insults to the environment and the individual that occur as a byproduct of industrial processes will receive the audience they merit only when they cease to be borne inaudibly by the general public

and enter the equation of economic gain or loss. This study has shown that humanitarian interests are articulated effectively only when economic considerations permit. Thus, to explain the evolution of problem-solving strategies, the attention of policy makers and scholars may focus to advantage on the economic degrees of freedom that characterize organizational contestants rather than on other theoretically interesting but practically trivial variables.

The second component of the theory of problem-solving offered here is that of interorganizational influence. As has been noted in Chapter IV, the literature on organizations has rarely gone beyond the stage of acknowledging that organizations affect one another in the course of acting with respect to problems. Although sundry writers have argued that organizational goal setting is affected by competitive, bargaining, co-optative and coalitional relationships, they have failed to specify the precise modifications in organizational behavior introduced by such relationships and the consequences of such modifications.

This study goes one step further in demonstrating the implications of a form of organizational influence. It will here be referred to as interorganizational coercion. Interorganizational coercion is used to mean the process by which organization A forces the leadership or policy determining structure of organization B to accomodate its (B's) behaviors to the wishes of a dominant organization (A) which can threaten the former's (B's) stability or existence. This implies that interorganizational relationships are characterized by conflict and imbalance. A dominant organization succeeds in achieving its ends; a subservient organization is forced to accomodate.

In this study, coercion may be seen in the relationship between uranium companies and government enforcement agencies. As such, it is a two-way street. Prior to the initiation of regulatory activities, including inspections and costly sanctions, the expenditures of the largest mining companies for ventilation were stable and minimal. During this period, through effective lobbying or negotiations, it is possible that the mining companies in effect were able to "coerce" government into ignoring the health hazards confronting underground miners. As one interviewee put it

> You have to remember that the mining industry is an old industry which has a history of limited regulation and a limited history of outside control. Ten years ago you just didn't jump in with regulations and orders and rules. The (mining) lobbies had more impact on the federal and state level. On the state level, of course, they still have a big impact, but it was really only in the last five to ten years that people started saying that life and not cost is the overriding factor. (148)

Then government becomes the coercer. Once government regulatory activities were initiated, the expenditures by mining companies rose. This was

crucial to the solution of the problem of excess radiation. Radiation levels in mines began to drop and the threat of imperilment to the health of workers diminished.

It is also worth noting that the absence of union coercion probably caused the deterioration of the health picture of the uranium miner. It seems likely that if unions had overcome the practical and financial barriers that made the unionization of uranium miners uneconomical and difficult, they would have exercised the needed coercive force on management to achieve a healthy environment for miners sooner.

Taken together, economic considerations and interorganizational coercion constitute the backbone of a theory of problem-solving among organizational actors. The theory asserts that problem-solving is determined by the economic interests of the organizational actor which can coerce its opposition. Thus, industry's interests will prevail to the extent it can head off coercion from government and union sources. Similarly, the worker will benefit to the extent that his union can coerce management to comply with its demands. As for the interests of the general public, the consumer and the unorganized worker, their hope lies in the independent advocacy actions of an enforcement agency which can coerce companies and unions whose actions threaten the public interest. Along with numerous other accounts, this study reiterates the urgent necessity for regulatory agencies that are uncompromisingly independent. At minimum, this requires the promotion and policing of industry to be separated. In point are the words of the Atomic Energy Commission's first chairman, David E. Lillienthal, on the dual role of the Atomic Energy Commission as both industry promoter and regulator:

> It is unfortunate that the AEC is not only the overall protagonist of a nationwide atomic power program; it is also the body that must sit as judge of the safety to the public of the design, mode of construction, and site of particular atomic power plants. In short, the AEC, as a general promoter of atomic power, must also decide the quaisi-judicial issue of whether a license is issued. With a word of goodwill and integrity and technical competence on the part of the AEC, how well is the public protected by this dual and conflicting role? (149)

Responsible representation of the public interest requires that independent regulators pursue the exclusive task of overseeing industry in the interests of the public.