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The Impact of the Occupational Safety and Health Administration on Workplace Safety in the United States

Angela Mattis Bernardo
Indiana University of Pennsylvania

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THE IMPACT OF THE OCCUPATIONAL SAFETY AND HEALTH

ADMINISTRATION ON WORKPLACE SAFETY IN THE UNITED STATES

A Dissertation

Submitted to the School of Graduate Studies and Research

In Partial Fulfillment of the

Requirements for the Degree

Doctor of Philosophy

Angela Mattis Bernardo

Indiana University of Pennsylvania

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Indiana University of Pennsylvania
The School of Graduate Studies and Research
Department of Sociology

We hereby approve the dissertation of

Angela Mattis Bernardo

Candidate for the degree of Doctor of Philosophy

_____   _____
                                             Dr. Willard W. Radell, Ph.D., Chair
                                             Professor of Economics, Committee Chair

_____   _____
                                             Dr. David Chambers, Ph.D.
                                             Associate Professor of Political Science

_____   _____
                                             Dr. Charles J. McCollester, Ph.D.
                                             Professor of Employment and Labor Relations

ACCEPTED

_____   _____
Michele S. Schwietz, Ph.D.
Assistant Dean for Research
The School of Graduate Studies and Research

Title: The Impact of the Occupational Safety and Health Administration on Workplace Safety in the United States

Author: Angela Mattis Bernardo

Dissertation Chair: Dr. Willard W. Radell
Dissertation Committee Members: Dr. David Chambers
Dr. Charles J. McCollester

This research examined the effectiveness of the Occupational Safety and Health Administration (OSHA) on reducing occupational injuries and fatalities in the United States. This research examined factors that may contribute to the success or failure of the agency to meet its mandate. Agency, economic, and workforce factors were considered to see how they influence occupational safety.

This research used available data from BLS, NIOSH, and OSHA and OLS regression models to determine the impact of the agency on occupational injuries and fatalities. A consistent time-series was developed for occupational fatality data that reconciled historic data and current fatality data. This time-series was regressed using agency, economic, and workforce factors to determine if the changes in occupational fatalities were due to OSHA. Regression models were also developed using occupational injury and illness data and agency, economic, and workforce factors to determine if changes in injury and illness data were due to OSHA.

This research found that higher budget allocations for the agency resulted in less incidents of occupational injury and illness. Budget allocations in all of the models tested using injury data showed that higher budget allocations resulted in less occupational injuries. Other models using workforce and economic factors were not free from fatal autoregression and could not be used. However, the results for occupational fatalities

were not as clear and did not produce models free from fatal autoregression when using

agency, economic, or workforce factors with the overall number of occupational

fatalities. When using the year-to-year difference in fatalities, the number of inspections

had the desired results.

The results of the OLS regression models using occupational injury data indicates

that the agency budget is an important and significant variable in ensuring that the agency

meets it mission. A recommendation from this research is to ensure that agency is

adequate funded and showing a presence in the workplace through enforcement and

outreach activities.

ACKNOWLEDGMENTS

I wanted to give special thanks for all of the people who have helped me along the way in this process. To my committee, cohort members, family, and friends who have been supportive of this entire endeavor, I am forever grateful. I would also like to dedicate this dissertation to all of the men and women who do not come home from work and especially to Jim Clark, who on July 11, 2007 became one of the approximately 5,000 in 2007 who did not come home.

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CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

Occupational health and safety has been a concern for employees, employers, and government for at least a century. According to the Bureau of Labor Statistics (BLS), in 2005, there were approximately 5,702 deaths in the workplace (BLS, 2006). In an effort to reduce the number of occupational injuries, illnesses, and fatalities, the United States opted to regulate industry. The Williams-Steiger Act, commonly known as the OSHA Act passed in December of 1970, was an effort to reduce the number of occupational injuries, illnesses, and fatalities (Mintz 1984). The Occupational Safety and Health Administration (OSHA), was given the task of protecting employees in the workplace from safety hazards that could lead to injuries, illnesses, and fatalities. The agency does this through setting standards and enforcing those standards with workplace inspections.

This dissertation examines the extent to which OSHA has decreased the number of occupational fatalities and injuries controlling for factors such as number of inspections and inspectors, economic factors, and workforce factors. A further objective of this research is to determine if the agency has had a leadership role in reducing and/or preventing occupational injuries and fatalities and the extent to which changes in the workforce have influenced the effectiveness of the agency and occupational injuries and fatalities. If the agency has an effect, what are the factors within the agency that are attributing to this effect?

Workforce factors include the number of union employees and employment statistics. There has been a steady decline in the number of union workers in the United States. In 1956, Bennett and Kaufman estimated that 1 in 3 workers in the private sector

belonged to a union. In 1998, that number was reduced to less than 1 in 10 workers

(Bennett & Kaufman, 2002). *Has this change affected occupational safety?* In addition,

other changes in the workforce also include a shift to service type industries and away

from heavy industries and overall increase of employees in the workforce.

Creating OSHA was a major change in how the country viewed and dealt with

occupational injuries and fatalities. Prior to the passage of the act, workers who suffered

workplace injuries were required to be compensated with workers compensation.

Workers compensation replaces income and pays for medical expenses in the event of an

occupational injury or illness (Hammer & Price, 2001). However, workers compensation

laws did not provide a means of being proactive to prevent accidents that led to worker

injuries or require employers to take preventive measures. The act was the first set of

United States regulations for the private sector that attempted to be proactive in

preventing injuries and occupational illnesses before they occurred in industry sectors

such as construction and manufacturing (Mintz, 1984).

Occupational safety and health is often judged by the number injuries and

fatalities sustained by employees. It is important to know if the resources that are utilized

by OSHA are being used in the best manner to prevent injuries and fatalities in the

workplace. Another measure of occupational safety is the cost associated with injuries

and fatalities. The costs in insurance premiums, lost wages, and lost productivity create a

substantial financial impact to businesses. According to the National Safety Council

(NSC), the cost of occupational injuries and deaths in 2004 (adjusted to 2001 dollars) was

approximately $133 billion, which includes approximately $68 billion for lost wages and

productivity, $24 billion for medical costs, $29 billion for administrative expenses and almost $7.5 billion for other uninsured costs to the employer and employee (NSC, 2005).

In addition, the external costs of occupational injuries, illnesses, and fatalities must also be considered. These events become a public health issue that reach beyond the injured employee to affect the entire society. When the employees' ability to earn is disrupted by an event such as workplace injury or death, the financial stability of the family is seriously threatened. Once self-sufficient individuals and families lose their ability to earn and to provide support, they become dependent on government services and public assistance for health care, housing, and food. Direct costs such as replacement of lost wages and medical bills are insured and are well documented. However, indirect and opportunity costs such as lost hours of production, years of work, ability to earn, and the hardship placed on the injured employee and their family are great and are not measured. Preventing workplace injuries has the potential to save the injured from countless days of pain and suffering.

In the early 20th century, activists began to criticize the high rates of death and injury in the American workplace (Rosner, 2000). Crystal Eastman in her report, Work-Accidents and the Law, wrote about the plight of workers and families who suffered an occupational injury or fatality in Allegheny County Pennsylvania. The report, which was part of the Pittsburgh Survey sponsored by the Russell Sage Foundation, focused on work accidents that occurred in 1906. According to Eastman, in 1906 there were 526 men killed at work in Allegheny County (1910). Eastman reviewed these accidents and looked at what caused them. In addition, Eastman also interviewed families and co-workers to understand the circumstances of the accident and the aftermath of losing a

wage earner. When reviewing the accidents, Eastman found that there were many ways in which to prevent those events. As Eastman states in reference to occupational fatalities,

> Is this loss a waste? This is a question which Pittsburgh and every industrial district must answer. If it is merely an inevitable loss in the course of industry, then it is something to grieve over and forget. If it is largely, or half, or partly unnecessary, a waste of youth and skill and strength, then it is something to fight about and not forget. (p. 15)

In Eastman's research, she describes the circumstances leading to the occupational death and some of the simple steps that could have prevented the incident.

Another activist who was instrumental in exposing harmful working conditions was Alice Hamilton. Hamilton, who is known as the *"pioneer of industrial medicine,"* was trained as a physician. Hamilton specialized in occupational diseases and questioned what the United States was doing to prevent known illnesses caused by lead and mercury in the workplace. Although occupational diseases related to these substances were well documented in Europe, precautions were not taken in the United States to prevent exposures or identify potential harm from new materials and technology. Hamilton was able to document the cause and effect of exposure to many substances and was instrumental in the development of standards and work practices in the United States that prevented many occupational diseases (Sicherman, 1984).

Eastman and Hamilton were influential in changing attitudes towards the causes of occupational injuries from the fault of the worker to the responsibility of the employer. In addition, workers who were injured on the job began to sue their employers and win.

This started the development of workplace safety procedures and workers compensation. In some instances, workplace safety procedures started as a way of protecting organizations from litigation by injured employees. This eventually resulted in the no-fault workers compensation system where employers agreed to pay for injuries and employees lost their right to sue their employer. The incentive for the employer is to make a safe work environment and prevent injuries, which would in turn reduce costs, associated with workers compensation (Rosner, 2000).

In addition to workers' compensation laws providing an incentive for industry to make a safe work environment, states and the federal government started to codify workplace safety procedures to ensure workplace safety. This was done because workplace injuries and deaths were still occurring even though workers' compensation was well established. This allowed the concept of providing a safe work environment through government regulation to migrate from the court system to regulatory agencies. In 1950, the National Safety Council (NSC) estimated that there were 15,000 occupational fatalities. In 1969, the NSC estimated that there were 14,300 occupational fatalities. This prompted the states and the federal government to codify workplace safety procedures, which later evolved into OSHA. Even with the OSHA regulations, workplace injuries, illnesses, and fatalities still occur. According to the Bureau of Labor Statistics (BLS) and NSC nonfatal injuries and illnesses occurred at a rate of 4.6 cases per 100 employees and fatalities occurred at a rate of approximately 15 per day or almost 5,000 per year in 2005 (BLS, 2006; NSC, 2006).

Preventing foreseeable harm is an ethical imperative and has the potential to improve business, but that good outcome is not without cost. Employers must invest time

and equipment to make a workplace safe. However, preventing occupational injuries also has the potential to reduce labor and fringe benefits costs to employers (Zaloshnja et al., 2006). Potential cost savings can be seen in increased productivity and decreased medical and insurance costs.

However, the cost of compliance or providing a "safe" work environment may vary greatly depending on the hazard and the industry. OSHA is required to demonstrate that a new standard is economically feasible before it is implemented (Seong & Mendeloff, 2004). If a new standard will place undue financial hardship on an industry, the standard may be scaled back or not implemented. In addition, if an employer is cited for a violation of a standard that is already codified and claims that it is economically infeasible to comply, abatement dates to correct the hazard may be extended indefinitely (Mintz, 1984). These provisions in the act give employers in highly hazardous industries many options.

Evaluating the agency to determine what is causing its effectiveness or ineffectiveness in preventing workplace fatalities can have far-reaching benefits to the working population. Continuing to do what works will prevent numerous occupational injuries and fatalities. In addition, eliminating what is not useful or proactive can allow resources to go to areas that can assist in the reduction of fatalities and injuries. However, looking at just the overall injury statistics may not give a good indication of the effectiveness of the Occupational Safety and Health Act.

Questions that need to be answered to determine the effectiveness of the agency include; *how has OSHA affected workplace safety in the United States since its inception in 1970? If there is a change in the rates, can this change be attributed to OSHA and its*

regulations or is it due to other factors? Is there a relationship between the number of

OSHA inspectors, inspections, budget amount, and the number of workplace injuries and

fatalities reported? Are the data collected on occupational injuries and fatalities

useable? If the data are not useable, what are some other ways to understand the impact

of the agency and how would you estimate its effectiveness?

The study of this topic is important to all the employees and employers affected

by the OSHA regulations. The OSHA regulations in many cases are the only guidelines

that employers have to prevent injury in the workplace and to protect their employees. In

addition, the agency is often the only recourse employees have to protect themselves

from job related injury and illness by filing complaints and requesting inspections

(Brown et al., 2000).

This research explores the history of OSHA and occupational safety in the United

States. This research discusses some of the available information regarding injury and

illness statistics and the limitations of the available data from the Bureau of Labor

Statistics (BLS) and National Safety Council (NSC). Some of the common criticisms and

alternatives to the agency are also discussed. In addition, theories such as deterrence

theory and moral hazard theory as they apply to enforcing OSHA standards were also

reviewed.

My experience as a safety and health professional with OSHA has exposed me to

many different industries and has allowed me to investigate occupational injuries and

fatalities. I am concerned that we are not doing enough to prevent and reduce the serious

injuries and fatalities in the workplace. My observations during the eleven years that I

worked for the agency included a shift of inspections from heavy industrial facilities such as steel mills to light manufacturing and service type industries.

In addition, my personal observation is that fatalities and injuries have stagnated instead of declined. It would be reasonable to deduce that workplace injuries and fatalities should be reduced as high hazard industries decline and as technology advances. However, my personal observation has not seen this reduction. In addition, I have often wondered if we have reached a plateau in the number of injuries and fatalities that can be prevented with current methods. If we have reached a plateau, we must find other ways to prevent injuries and fatalities.

This research is important to me because of the human face is often forgotten when there is an occupational fatality. In my opinion, occupational fatalities are not perceived as newsworthy events and are underreported by media. Compounding issues such as the loss of a wage earner, loss of activity by a person and the subsequent effects on the home, family and personal stability of those directly affected are often over looked. In addition, the agency is often criticized for being ineffective in preventing occupational injuries and fatalities.

Purpose and Objectives of this Study

The purpose of this study is to determine the effectiveness of the Occupational Safety and Health Administration (OSHA). The main objective of this study is to understand how the current system of enforcement of occupational safety and health regulations has influenced occupational fatality trends and occupational injuries and illnesses. This study has examined the traditional indicators of occupational safety.

These indicators include overall injuries and fatalities and the accepted rates of these incidents. In addition, this study also looked at economic factors, variables in the workforce, and variables within the agency to determine what impact these factors have had on occupational safety. Just as there are multiple factors that lead to an accident and/or injury in the workplace, there are also multiple factors that prevent or deter accidents and the resulting injuries. This study looked at multiple factors to determine if there is a relationship between OSHA and workplace injuries and fatalities.

There has been an obvious decline in the number of occupational injuries and fatalities. In 1969, the NSC estimated that there were 14,200 occupational fatalities (NSC, 1971). In 2005, the NSC estimated that there were 5,702 workplace fatalities (NSC, 2006). The purpose of this study is to determine the extent to which the decline in the number of fatalities is due to regulatory efforts or other factors, and to determine the benchmark levels of Agency Factors that will help achieve lower injury and fatality rates.

In an effort to contribute to the literature, this study attempted to investigate if there is a relationship with OSHA and the number of occupational fatalities when controlling for factors such as GDP, unions, and the number of employees. Examining the raw numbers provided by BLS and NSC shows a decline in occupational fatalities. However, what the BLS and NSC data does not show are how other factors related to the agency and the workplace may be affecting the number of workplace fatalities. In addition, this study will offer insight into the workings of the agency in the field from my own personal experience.

Much of the current literature focuses on short time spans, specific demographic groups or specific industries. Research examining the overall effectiveness of OSHA

from the beginning to recent times is lacking. This dissertation reviews occupational safety from the time prior to the implementation of OSHA thru to the present in order to see what the impact the agency has had on occupational safety and how specific factors have influenced trends.

Research Questions

The following research questions were explored in this study:

1. Occupational injuries and fatalities have decreased since the inception of OSHA. Can any of this decrease be attributed to OSHA?

2. How have workforce and economic factors influenced the number of occupational injuries and fatalities?

3. Since the inception of OSHA, what is the relationship of the agency's budget, number of inspections, and number of inspectors to injuries and fatalities?

4. Has OSHA had a statistically significant impact on reducing occupational injuries and illnesses or are other factors responsible for the observed decrease in occupational injuries and illnesses?

5. How have the number of inspectors, appropriations, political party, and economic factors influenced the number of occupational injuries and fatalities?

6. To what extent have data from the Bureau of Labor Statistics and the National Safety Council helped or hindered the understanding of occupational injuries and fatalities?

H_1 The creation of OSHA has decreased occupational injuries and fatalities.

H_0 The creation of OSHA has no effect on occupational injuries and fatalities.

H_1 The numbers of OSHA inspections, inspectors, appropriations, political party,

labor trends and economic indicators have an impact on occupational injuries and

fatalities.

H_0 The numbers of OSHA inspections, inspectors, appropriations, political party,

labor trends and economic indicators have no impact on occupational injuries and

fatalities.

H_1 As the number of OSHA inspectors, inspections, budget amount, citations and

penalties increase, there is a decrease in workplace injuries, illnesses and

fatalities.

H_O There is no statistically significant relationship between the number of OSHA

inspectors, inspections, budget amount, citations and penalties and workplace

injuries, illnesses and fatalities.

Significance of the Study

The cost of workplace injuries and illnesses has always been high. The National

Safety Council (NSC) has developed cost measurements for occupational injuries,

illnesses and fatalities for all industries. Tables 1 and 2 provide a summary of the NSC

estimates of the costs of occupational injuries and fatalities. The tables have the cost of

injuries as provided in the source year and the cost of the injuries adjusted to 2001-dollar

amounts. In addition, Table 1 presents data from the survey method used by the Bureau

of Labor Statistics (BLS) to count occupational fatalities prior to 1992 and Table 2

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presents the data from the BLS Census of Fatal Occupational Injuries (CFOI) method

used since 1992. Prior to the development of the CFOI, NSC relied on their own method

of obtaining data on occupational injuries (Drudi, 1997).

Table 1. *Summary of Workplace Deaths and Costs of Workplace Injuries, Illnesses &
Death Based on NSC Data 1950-1991*

Year	Occupational Deaths	Costs (Billions)	Adjusted Costs 2001 (Billions)	Year	Occupational Deaths	Costs (Billions)	Adjusted Costs 2001 (Billions)
1950	15,000	2.50	18.37	1971	13,700	9.30	40.67
1951	16,000	2.65	18.05	1972	14,000	11.50	48.72
1952	15,000	2.90	19.38	1973	14,300	14.00	55.84
1953	15,000	3.15	20.89	1974	13,500	15.30	54.96
1954	14,000	3.20	21.07	1975	13,000		
1955	14,200	3.50	23.13	1976	12,500	17.80	55.4
1956	14,300	3.75	24.42	1977	12,900	20.70	60.49
1957	14,200	4.00	25.21	1978	13,100	23.00	62.47
1958	13,300	3.90	23.9	1979	13,000	27.30	66.6
1959	13,800	4.20	25.56	1980	13,200	30.20	64.91
1960	13,800	4.40	26.33	1981	12,500	32.50	63.32
1961	13,500	4.60	27.25	1982	11,900	31.40	57.63
1962	13,700	5.00	29.32	1983	11,700	33.40	59.39
1963	14,200	5.00	28.94	1984	11,500	33.00	56.25
1964	14,200			1985	11,500	37.30	61.39
1965	14,100	6.40	35.98	1986	11,100	34.80	56.23
1966	14,500	6.80	37.17	1987	11,300	42.40	66.10
1967	14,200	7.30	38.71	1988	11,000	47.10	70.51
1968	14,300	9.00	45.8	1989	10,900	48.50	72.61
1969	14,300	9.00	43.43	1990	10,100	63.80	91.12
1970	13,800			1991	9,800	63.30	90.41

Table 2. *NSC & BLS Data on Occupational Deaths Based on CFOI and NSC Cost Information 1992-2005*

Year	Occupational Deaths	Costs (Billions)	Adjusted Costs 2001 (Billions)	Year	Occupational Deaths	Costs (Billions)	Adjusted Costs 2001 (Billions)
1992	4,968	115.90	146.3	1999	5,184	122.60	130.33
1993	5,034	111.90	137.15	2000	5,022	131.20	134.93
1994	5,338	120.70	144.24	2001	5,042	132.10	132.10
1995	5,015	119.40	138.78	2002	4,726		
1996	5,069	121.00	136.58	2003	4,725	153.20	147.45
1997	5,160	127.70	140.91	2004	4,999	142.20	146.20
1998	5,117	125.10	135.92	2005	4,961	160.40	145.45

In addition, to these monetary costs, the costs to society are also great. When an injury occurs, there are losses of wages to those directly affected by the injury. Workers compensation covers most of the lost wages and medical costs. However, there is a waiting period and a finite amount that will be paid to the injured employees. There is also the issue of loss of activity. An employee who lost a hand in an industrial incident will usually be compensated with what is known as a scheduled loss. A scheduled loss is in-essence a price tag of what a finger, limb, or scar costs (Goestsch, 2005). However, the scheduled loss does not compensate the employee for not being able to participate fully in life events or activities.

In addition, this study may also help determine what factors aid the Occupational Safety and Health Administration (OSHA) in meeting its mission. This study may show the threshold number of inspectors, funding, and inspections that allow the agency to be successful. The study may also show that the current methods used by the agency have been effective in lowering the injury rate. The agency has often attempted to utilize ways

to leverage its resources in order to meet its mission. It is important to understand if the agency is meeting its mission and resources are being used effectively.

Limitations

One of the limitations of this study is the data that are available to evaluate the impact of the agency. Throughout the history of data collection on occupational safety issues, there have been numerous methods of collecting data on occupational injuries, illnesses, and fatalities. The main sources of data were from the Bureau of Labor Statistics (BLS), National Safety Council (NSC), and National Institutes of Occupational Safety and Health (NIOSH). In addition, demographic and economic data came from the Census Bureau and the Bureau of Economic Analysis data sets.

A method was developed in this research to reconcile the numerous methods of accounting for occupational fatalities, using a combination of data sources from NIOSH, NSC, and BLS. In addition to occupational fatalities, occupational injuries and illnesses were reviewed. Using the BLS reported numbers and rates were determined to be the most accurate available data set for injuries and illnesses. As is explained in later chapters, these data sets for occupational fatalities and occupational injuries and illnesses were used to determine the effectiveness of the agency.

CHAPTER II

LITERATURE REVIEW AND HISTORICAL

INFORMATION ON OCCUPATIONAL SAFETY

Introduction

This chapter reviews the current literature on the effectiveness of OSHA. In addition, the historical background of OSHA and a brief history of occupational safety in the United States were also reviewed. The chapter is divided into six sections with the first section discussing current literature on the effectiveness of OSHA. The next section reviews some of the common criticisms of the agency. The third section covers theory related to the topic. The fourth section reviews the possible alternatives to the agency. The fifth section reviews the history leading to the passage of the act. The final section reviews the history of assistant secretaries and agency policy.

Current Literature

Investigating the effectiveness of OSHA has been the topic of previous studies. Many of these studies focus on a small segment of the covered industries or a certain group of employees. Previous studies have limited their exploration of the agency to particular standards or a short span of years, while other studies have looked at safety in a particular industrial sector. These studies are useful for that particular industry or time span but have little impact on assessing the overall value of OSHA or understanding how the combination of internal agency factors, economic factors, and workforce factors affect the agency.

One way in which OSHA can influence safety in the workplace is to deter

employers from violating OSHA standards. A way that OSHA accomplishes this is to

issues citations and penalties. However, penalties are often a subject of intense debate as

to whether they are effective in reducing occupational injuries, illnesses and fatalities. In

an effort to determine if penalties are an effective deterrence tool, Davidson, Worrell and

Cheng (1994), used a unique approach of looking at how OSHA penalties affected the

residual owners of a company. They defined the residual owners as the shareholders in

the company. In their study, if an announcement of an OSHA penalty led to a decrease in

the stock price for the company, the company would have additional financial incentives

to comply with the standards. If however, there were no reaction in the stock price, the

penalties or other sanctions would not be considered an effective deterrent. The

argument used by the authors is that if there is a negative impact on the stock price, the

shareholders will place pressure on management to change their ways and thus improve

safety in the workplace.

The research focused on companies that had citations and fines that resulted in

press coverage between 1979 and 1989. Previous research complied by Davidson et al.

(1994), showed mixed results in the effectiveness of the agency. The authors' sample for

the study was obtained from a keyword search in the National Newspaper Index on

OSHA related penalty stories. These stories came from the Wall Street Journal, New

York Times, Washington Post, and Los Angeles Times and resulted in 63 cases. They

compared the change in the stock prices of these companies near the time of the press

release about the OSHA inspection. Using Agency Theory, which states, "the securities

markets and the threat of outside takeover, act as strict incentives to managers and force

them to operate the firm for the benefits of its owners." Davidson et al. found that OSHA penalties have little effect on the value of the stock (1994). Thus, they concluded that since the residual owners were not influenced by the OSHA penalties, the company was not influenced by market discipline to be safer.

However, there are many limitations to the Davidson et al. study. As noted by the authors, a limitation was that the inspections had to be newsworthy events to make the press and thus make it into their analysis (1994). In addition, OSHA has many inspections at facilities that are not considered newsworthy events but may have an impact on the profitability of the company and the focus of management. Many inspections occur at companies that are not publically traded, owned by small business owners, or in areas where the news did not reach one of the papers reviewed. These facilities may see an additional financial incentive to comply with the standards because the amount of the penalty affects the bottom line. In addition, in smaller organizations it is much harder to ignore an unsafe condition when you see it every day and know the employees versus one that you hear about that is not on your premises.

According to Davidson et al. hypothesis, without the economic incentive, the management culture will not change and safety will not improve. What the researchers found is that the market does react in a negative manner at the time around the announcement of the citation and penalty. However, the reaction is short lived and the effect wears off quickly (Davidson et al., 1994). The long-term financial impact of an OSHA inspection with citations may be minimal at best. There may also be additional reasons for the weak impact such as efficiency of the company, demand for the products,

and the type of incident that initiated the inspection (i.e. accident, fatality, employee complaint) that explain the initial reaction of the stock (1994).

Another way to determine if OSHA has a deterrence effect on organizations is to look at company's who have received multiple inspections. If deterrence is working, then subsequent inspections should show a reduced number of citations and thus compliance with regulations that will reduce incidences of injuries, illnesses, and fatalities. A study conducted by Gray and Jones (1991$_b$), looked at the effect of sequential inspections on compliance with OSHA standards. Using data from the OSHA Integrated Management and Information System (IMIS), the inspection history of specific companies and locations were tracked to determine the number of citations received by the companies from 1972-1983. The results of the analysis showed that the initial inspection at the facility produced the most citations and subsequent inspections resulted in a 50% decline in the number of citations received. According to the authors, "first inspections provide substantial information to firms which, increases their propensity to comply with the standard." In addition, the authors theorized that eventually there would be equilibrium between penalties of noncompliance and compliance costs (1991$_b$). This would indicate that for some organizations the agency becomes just another cost of doing business with little impact on safety.

However, the cost of compliance can vary greatly from location to location, thus making some of the comparisons difficult. For instance, an unguarded saw can be easily corrected and inexpensively fixed with a shield. However, complicated issues such as installing a local exhaust ventilation system to prevent exposure to airborne contaminants are much more complicated and expensive. In addition, compliance may not result in a

safer work place if there are no standards to enforce or if hazards go undetected by the organization and OSHA. Gray and Jones did not look at the impact on the injury rates at the facility after an inspection occurred.

This dissertation will further expand upon the notion of OSHA being a catalyst for change in the safety culture and program in an organization. There may come a point where the agency has reached its maximum effectiveness. Often when an inspection occurs, in addition to the cited items, an organization will begin to examine their entire safety program. However, for some organizations there is a cost-benefit breakeven point where the cost of citation is less expensive than the cost of compliance.

However, the mission of the agency is to reduce the number of occupational injuries, illnesses, and fatalities in the United States. If the agency is meeting its mission, incidents of these events should be continuously decreasing. In a study conducted by Ruser and Smith, they analyzed what they described as a "longitudinal micro data set for manufacturing establishments covering the period from 1979 through 1985." They found in their review of the literature that OSHA had "little or no effect on injury rates in the 1970s" (1990). They also found that there were conflicting findings in the literature that OSHA has had an effect on injury rates in the 1980s. They attempted to clarify this issue in their own study. They separated the effects of OSHA into two broad categories. The first category was "the effects in advance of inspections (owing to increased awareness of problems or to voluntary compliance with mandated standards)". The second category was "the effects that are forced on employers after the inspection." They found that there was little evidence to show that the inspections had a negative effect on the injury rates or reduced the injury rates (Ruser & Smith, 1990).

Using BLS data from 1979 through 1985, Ruser and Smith, matched records from the annual survey of injuries and illnesses. From this data set, they used the locations that were inspected early in the year and compared those establishments with establishments of similar characteristics that were inspected later in the year. From these groups they looked for inspection effects in the current year and the year after the inspection. Using regression analysis they found little evidence to suggest that the OSHA inspections in their time period analyzed were effective, thus indicating that the agency is not effective (Ruser & Smith, 1990).

However, others have found indications that inspections do make a difference in the injury rates. Mendeloff and Gray (2005) attempted to explain, "Why inspections that cite penalties reduce injuries." In their previous research, they found preventative effects of OSHA inspections at smaller firms. However, in firms with more than 250 employees they found "no preventive effects of these inspections" thus indicating that smaller establishments are more influenced by OSHA. In their study, they identified three models that may explain their findings.

In the first model, they assume that the injuries prevented are directly related to the standards cited by the compliance officer (Mendeloff & Gray, 2005). In this model, they are depending on the compliance officer to be able to recognize the hazard and identify a sustainable standard to cite. Unfortunately, this model does not take into consideration the changing dynamics of the workplace and other potential hazards that may not be recognized. As Mendeloff & Gray discuss, only the injuries that would have been caused by the cited item would be prevented (2005).

The second model presented by Mendeloff & Gray (2005), contends that the overall inspection and penalty "will induce a greater overall compliance effort." This model takes into account the fear of a return inspection that may find similar or other hazards associated with OSHA standards. In this model, companies concerned with future penalties will attempt to avoid those penalties by improving their overall safety program and becoming proactive in recognizing and preventing hazards. The incentive for the employer to do this is that repeated violations have the potential to carry a larger penalty than the initial violation. This shows that inspections and OSHA could actually have a proactive effect on reducing violations and thus injuries.

The third model presented, relates to managers and their ability or willingness to cope will all aspects of production. As stated by Mendeloff & Gray (2005), the model "assumes that managers cannot optimize with respect to all aspects of their operations and tend to focus their attention on what appears to be most important at the time." When an OSHA inspection is being conducted, that is important and the focus is shifted to safety. When the inspection is over, other responsibilities become a priority and safety becomes an afterthought. This model may be especially true when dedicated resources are not provided for the safety function and the managers are not trained in safety regulations.

Mendeloff and Gray tested the three models developing a data set based on BLS data from 1992 to 1998 and OSHA inspection data. They found "weak support for the first model and limited support for the second." This indicates that citations can prevent injuries and that an inspection influences the safety culture of the organization suggesting that inspections also have an impact on injuries unrelated to standards. This finding

supports the notion that the presence of OSHA has an effect on the overall safety of the facility even if it does not directly address the hazard.

The indirect effect of OSHA is often discussed in the literature. However, this indirect effect is difficult to measure. Bartel and Thomas looked at the impact of OSHA by evaluating the direct and indirect effect of the regulations (1985). According to their model, the evaluation of the agency is not a simple process and to understand fully the effects of the agency you must use a three-equation model. Their three-equation model looked at accidents, noncompliance and enforcement in the years 1974-1978. In addition, their research focused on two hypotheses as to explain the apparent failure of the agency in reducing injury rates as found in previous research.

The first hypothesis that Bartel and Thomas reviewed was the noncompliance hypothesis. The basis of this hypothesis is that OSHA is ineffective because of budgetary and statutory constraints that do not allow the agency to ensure compliance with the regulations (Bartel & Thomas, 1985). The second hypothesis, known as the inefficacy hypothesis refers to the perspective that the OSHA Act itself is flawed (1985). The rationale behind this statement is that the standards that have been promulgated by the act look at unsafe conditions and require that capital investments be made in order to improve safety. However, achieving occupational safety is much more complex. According to Bartel and Thomas, "accidents are in fact caused by complex epidemiological interactions of labor, equipment and the workplace environment" (1985) and are caused by multiple factors.

Bartel and Thomas found a weak linkage between noncompliance and workplace accidents leading to the conclusion that the inefficacy hypothesis is correct. According to

their hypothesis, the act is flawed because the standards do not prevent accidents. Their study also found that there "are significant effects of OSHA enforcement on industry violation rates, indicating that the noncompliance hypothesis is false," thus indicating that there are adequate resources for the agency to meet its mission. In addition, Bartel & Thomas raise an intriguing reason as to why the act and the agency are needed and continue to be supported. They concluded that the indirect effects of OSHA regulations are real, significant, and may outweigh the direct effects (1985).

A study conducted by Haviland et al. looked at the impact of OSHA inspections and penalties and their effect on workplace injuries (2008$_a$). In addition to supporting the idea that an inspection, citation, and penalty lead to an overall improvement in the safety culture of the organization, they also found that the organization cited focused in on the specific hazard. Like Bartel and Thomas, Haviland et al. assert in their research "the preventive effects of inspections are not necessarily limited to those hazards addressed by OSHA standards (2008$_a$).

The indirect effects may be what are necessary to continue the use of the agency. These indirect effects may be perceived as the threat of an inspection and thus encourages facilities to comply. It is possible the indirect effects have the most influence on the agency and on the workplace. This research may be able to show that there are some indirect ways that the agency is contributing to the overall decline in workplace injuries, illnesses, and fatalities despite some of the shortcomings of the agency. However, to determine if this is possible, it must be established that other causes such as changes in the workforce and industry are not causing changes in injury and fatality rates.

In addition, expanding on the noncompliance hypothesis of Bartel and Thomas, this dissertation took into account budgetary and staff commitment in regards to OSHA. If the agency is to be successful in lowering fatalities and injuries, adequate resources must be provided to the agency. If the indirect effect of the agency, which is the mere presence of the agency, is important in reducing occupational injuries, illnesses and fatalities, then the agency needs to be a known and respected presence in the workplace. If declines in occupational injuries, illnesses, or fatalities are not seen, this could be because of a lack of resources to make the presence of the agency effective.

Accidents that lead to occupational injuries and fatalities are a result of a combination of many factors. These factors converge at the same time with the victim, causing an injury or fatality. These same factors could also converge at another time and create a "near-miss" incident but are not recognized as an event that could cause injury. In essence, OSHA and OSHA compliance are one piece of the puzzle. Other factors include resources allotted to employees and management systems in place to identify potential adverse consequences and conditions.

A study conducted by Brown et al., (2000), looked at the interaction between social systems, technical systems, and cognitions as possible causes for accidents and injuries or the prevention of them. In their study, they looked at three general themes that are related to causes of accidents and thus injuries. These themes include "causes involving the person, causes involving the system, and causes involving system-person sequential interrelationships" (Brown et al., 2000).

In their study, they hypothesized that both the system and the employee influence safety and that the system effects occur indirectly through the person (Brown et al.,

2000). They conducted a survey of employees working in the steel industry and used a covariance structure analysis (CVA) to analyze the data. They found that safety hazards and production pressures have a profound influence on the employee's decision to work safely or not to work safely. They concluded that accidents are not simply caused by unsafe acts of the employee but that the causes of accidents are much more complex and that the operating and social environment is important to safe actions of the employees (Brown et al., 2000).

Brown et al. did not look at the impact of OSHA but looked at the culture of the organization and in only one industry. One of the difficulties in evaluating the impact of the agency is the complex nature of all the organizations affected by the agency. The root causes of injuries are complex and need a series of events in order to become an injury. Failures in preventative maintenance, employee training, and the management system also have a role in injury and illness prevention. In many investigations, the root causes of incidents are missed because the investigation stops when human error is found. However, in many instances the human error is a result of the complex environment in which the employee works.

In this dissertation, production pressures were explored by examining economic factors such as GDP and its relationship with workplace injuries and fatalities. In my experience with OSHA, I have seen many industries where there has been a decline in the number of workers but production demands and pressures have stayed the same or have increased. Sometimes it is these demands that lead to an injury.

In addition to studies that dispute the effectiveness of the agency in reducing occupational injuries and fatalities, some studies have shown that OSHA standards are

effective in reducing the number of fatalities. A study conducted by Suruda et al.,

showed that the number of trenching fatalities were greatly reduced when the revision of

the OSHA standard on trenching and excavation was implemented. In the five years after

the standard was revised, they found that there was a 66% decline in fatal trench injuries

from 1990 to 1995. They attributed this decline to the emphasis program that targeted

trenching following the implementation of the standard. However, they also

acknowledged that some of the reduction might have been due to the recession in 1991

and 1992 and a decline in construction (Suruda et al., 2002).

When OSHA promulgates a standard, it must come up with a justification as to

how the standard will affect the workplace. Some of the issues that are reviewed are

costs of compliance and lives saved. This cost/benefit information is developed by

OSHA in the "Regulatory Impact Analyses" (RIAs) (Seong & Mendeloff, 2004). The

RIAs were a result of Executive Order 12291 issued by President Reagan which requires

a cost/benefit analysis of new regulations (Cooper & West, 1988). The benefits in the

RIAs include predicted lives saved and efficiencies gained if the standard is

implemented.

A study conducted by Seong and Mendeloff (2004), looked at the RIAs to

determine if the projected lives saved matched the actual lives saved. They looked at 11

standards that were promulgated since 1990. From these standards, they choose six that

predicted the greatest number of deaths prevented. Many of the studies reviewed in the

Seong and Mendeloff paper looked at projected potential lives saved but did not follow

up to verify if the predictions were accurate. Seong and Mendeloff conducted a

retrospective study to determine if the predictions were accurate. In the six standards

reviewed, the accuracy of projections ranged from "somewhat overestimated" to "greatly overestimated." One of the reasons that the authors give for this overestimation is that OSHA must assume that there is full compliance with the regulation when making these estimates (Seong & Mendeloff, 2004). In reality, it is rare to have full and complete compliance across industry groups and thus the predictions and the actual numbers do not match. However, what the study did not discuss is if the compliance with the actual standard would have prevented the deaths. If compliance with the standard should have prevented the death, then the standard as written is actually good and only compliance and enforcement efforts are lacking. OSHA has two functions with compliance, promulgating the standards and enforcement of those standards. Often what is missing from the debate about the effectiveness of OSHA is the employers' obligation to comply with the standard. By the act, employers are to provide a safe and healthful work environment.

If compliance with the standard would not have prevented the event, additional hazards need to be identified and addressed by the standards. However, even if there is no specific standard from OSHA related to the safety issue, the employer is obligated to comply with the general duty clause. The general duty clause is an all-encompassing statement in the Act that states that the employer shall provide a safe and healthful work environment. What this means from a compliance standpoint is that a company can be cited if there is a recognized hazard that is not controlled (FIRM, 1999).

Union status has also been a factor evaluated when determining safety of an organization. Baker and Scherer (1997) looked at 3,000 OSHA inspections from 1989 to 1994 in an effort to determine if there was a relationship between the union-status of the

firm inspected and the safety on the site. In their study of the previous research on the topic of safety on union vs. nonunion construction sites they found conflicting results. Their research question was, "are there significant differences between union and non-union construction firms in terms of safety, as indicated by OSHA safety inspections?" The researchers used the OSHA IMIS database to access the data set used in their study. Once the data set was determined, the researchers used bi-variate correlations to determine relationship between the factors studied.

They found that union firms had fewer cases of lost workday injuries, number of violations, and number of serious violations. There was no difference found in the other variables such as inspection scope, litigation hours, onsite hours and total penalties. The researchers found that the injury rate for the nonunion firms was approximately 1.5 times higher that the union firms and those non-union firms had 15% more serious violations (Baker & Scherer, 1997). As explained by the authors, a limitation of their study is that it only took into account construction workers for 1989-1994. The study does not look at individual sites or companies and may not be transferable to every jobsite, company, or sector.

Although the literature still does not provide conclusive evidence of the impact of OSHA on workplace fatalities and injuries. Some of this may be due to the short duration of the studies or the limited industrial sectors studied. However, many of the studies acknowledged that OSHA has had an impact on safety even though there are gaps in standards enforced by the agency. In addition, the agency must continuously improve its efforts to ensure the safety of the workforce.

Critics of the Agency

Even with some of the gains made in occupational safety since 1970, since its inception, OSHA has been criticized for not being effective in preventing workplace injuries and illnesses. OSHA critics have been very vocal for and against enforcement of the OSHA Act and the resulting regulatory standards. One of the most prominent criticisms of OSHA targets the penalty system. Those who want stronger enforcement feel that the penalties are too low. Those who want less enforcement and a "business friendly" environment feel that penalties disproportionately affect smaller businesses and that the penalties would be better used by being reinvested in the organization.

However, in some circles, the penalties issued by OSHA are considered just the cost of doing business (Barstow & Bergman, 2003; Gray & Scholtz, 1993). In other instances, the penalty is not a concern and is so low that it hardly has a deterrence effect. Litigation because of a lawsuit, EEOC complaint, or making the capital investments necessary to comply with the standards is much more significant than penalties resulting from an OSHA inspection (Zimmerman, 2005). Table 3 provides a summary of the citation classifications and maximum penalty amounts (Firm, 1999).

A serious violation is a violation of a standard that is likely to cause serious physical harm or death to an employee (FIRM, 1999). The maximum penalty for a serious violation is $7,000. However, penalty amounts are often lower because of adjustment factors that are applied to the violation. These factors include the likelihood of this violation causing injury and the likely severity of the injury.

Table 3. *OSHA Penalty Classification and Monetary Assessment*

Citation Classification	Maximum Assessed Penalty
Other- than-Serious	$1,000
Serious	$7,000
Willful	$70,000
Repeat	$70,000

The claim that excessive penalties adversely affect small business is not as clear as it may seem. According to the Field Inspection Reference Manual (FIRM), used by OSHA to determine penalties, small employers can receive up to a 60 percent penalty reduction because of the size of their company (1999). A small employer is defined as a company with less than 250 employees. In addition, there are also adjustment factors for inspection history and good faith, which can reduce the penalty by an additional 35 percent (FIRM, 1999). This means small employers with less than 10 employees, with no inspection history as defined by the FIRM, who shows good faith during the inspection can receive a 95 percent penalty reduction before a citation arrives at their door (see Appendix A for an explanation of the gravity based penalty system and penalty reduction factors). In this case, if the initial penalty amount were $5,000 before the penalty reduction factors were applied, the employer would be liable for a $250 fine. There are additional adjustment factors based on the seriousness of the cited event and the likelihood of causing injury to the exposed employee.

The agency is notorious for cutting penalties to prevent court cases and failing to collect past due penalty amounts (Barstow & Bergman, 2003). The penalty system is

designed to lighten the burden on smaller organizations and help those who show an effort to prevent workplace injuries. Furthermore, the agency is under a lot of pressure to ensure that cases are settled and stay out of court. In an effort to settle cases, penalties are reduced, citations are dropped, and abatement dates are extended (Lofgren, 1989).

Another criticism of the agency is the lack of criminal prosecutions. Few cases are elevated to the "criminal willful" level even though, between 1982 and 2002, there were 1,242 deaths from willful violations of OSHA standards. Of these deaths, 93% were never prosecuted (Congress Daily, 2004). Another source states that only 151 cases have been referred to the justice department for prosecution and only eleven people have ever been sent to prison (Barstow & Bergman, 2003). Even if prosecuted, people and corporations convicted of a "criminal willful" violation face a misdemeanor with a maximum $250,000 fine for an individual or $500,000 fine for a corporation and up to six months in jail (OSHA Facts, 2006).

A notable case that did receive criminal prosecution was the Imperial Foods fire that occurred in 1991. Imperial Foods received an $800,000 fine by the North Carolina OSHA. Certain states, such as North Carolina, have taken the option of operating their own OSHA program. The state programs are required to be at least as effective as the federal OSHA program. The 1991 Imperial Foods fire in Hamlet, North Carolina, where 25 workers lost their lives, is another example of a multiple fatality accident that could have been prevented (Jefferson, 1993). The high fatality rate was exacerbated because of a basic disregard for safety in the form of locked exits because the employer believed that employees were stealing chicken parts. The former ice cream factory became an incinerator for 25 employees when a hydraulic line ruptured and the fryer flame ignited

the hydraulic fluid. In this case, the owner was prosecuted by the state of North Carolina and was sentenced to a prison term (Elhassan, 2000).

The prison term in this case was a substantial variance from the status quo when prosecuting companies and individuals who are involved in workplace fatalities. Criminal prosecutions in OSHA are rare because of the high legal standard that must be met and the limited litigation resources. Criminal prosecution can only occur when an established OSHA standard is willfully violated and there is a fatality. Only then, can the case be elevated to the level of "criminal willful" and the person or corporation charged under the criminal statute of the act (FIRM, 1999).

However, the tragedy of this incident in North Carolina did not end with the fatalities or the other employees who were seriously injured in the fire. March et al. (1997) conducted a study fourteen months after the fire on posttraumatic stress symptoms in children and adolescents. The ones who were most affected and showed the most symptoms of posttraumatic stress syndrome were children of the dead and injured employees, and children who knew the victims of the fire at the plant (March et al., 1997). Occupational injuries obviously affect the injured employee; however the effects on families, children, and the community are often underestimated and not considered when calculating the costs of occupational injuries.

The number of inspectors is also a source of contention about the agency. Those who feel that agency is too weak contend that there are too few inspectors. Those who disagree argue that there are more than enough inspectors. During the administration of President Reagan, the agency lost many inspectors. In 1980, the peak number of employees for the agency was reached with 2,915 full time employees working for the

agency. The agency had a large reduction in force (RIF) at the beginning of the Reagan

Administration, from which it has never recovered. It was also during this time that the

agency had its first budget cut (Vike, 2007). In 1986, the number of full time employees

for the agency was reduced to 2,166 (OSHA Facts, 2006). The next peak in staffing

occurred in 1991, when there were approximately 2,466 full time employees. In 2005,

the number of full time employees for the agency was about 2,200 (OSHA Facts, 2006),

the result of a steady decline by attrition.

Critics of the agency have often focused on the regulations themselves. OSHA

has had a difficult time in setting new standards. When the agency was created, it was

given two years to adopt already established consensus standards. These standards were

known as the start-up standards that the agency adopted from established consensus

organizations such as the American National Standards Institute (ANSI) (Mintz, 1984).

Approximately 4,400 consensus standards were adopted by the agency during the startup

phase (Anderson et al., 1986). The blind adoption of these consensus standards has

created difficulties for the agency since its inception. There were many errors in the

standards and many of the standards were not relevant or did not protect the health and

safety of employees (Mintz, 1984). In addition, standards that the agency attempted to

set were delayed by court cases. OSHA must write standards that are broad enough to

apply to every worksite and situation regardless of the unique hazards and conditions

found at those worksites.

However, even with all of the controversy surrounding the effectiveness of

OSHA, it is important to remember why the agency was created. The mission of the

agency is described in the act itself, "to assure safe and healthful working conditions for

working men and women" (Public law 91-596 84 STAT 1590 91st congress, S2193, December 29, 1970). It is also important to note that there has been a decline in the overall number of fatal occupational injuries.

Theory

There were many arguments as to why or why not a regulatory agency such as OSHA was needed in the debates leading to the development of the agency. On one side of the debate were the proponents who wanted a regulatory agency to drive safety and health policy. On the other side were the employers who believed that workers compensation insurance is the only system necessary to ensure workplace safety. Theoretically, workers compensation insurance should allow the free market to encourage workplace safety and thus prevent accidents. Employers with poor safety records would be punished with higher premiums. In addition, workers compensation would directly reach all employers, where as an OSHA inspection would only reach a select few.

However, some argue that the moral hazard associated with workers compensation and regulations actually causes injury rates to increase (Moore & Viscusi, 1989). A moral hazard would increase the risk taking behavior of the employer and employee. On the same theme, there is also the issue of moral hazard as it relates to the regulation of workplace safety in the form of OSHA regulations. Lanoie describes moral hazard as "a generic phenomenon defined as the effect of insurance on the choice of self-protection activated by the insured when the insurer cannot observe or enforce the activities" (1991). When applying workers compensation insurance to the concept of

moral hazard, there may be an incentive for risky behavior in relation to preventative measures taken by the company. An example of this would be an employer opting to forego maintenance on the sprinkler system in a building that results in a defunct fire suppression system. The employer is insured against loss due to fire and is willing to take the risk of losing the building and contents because they will be replaced by insurance. In addition, employees may be inclined to accept high-risk jobs/tasks or perform tasks in a manner that they know is unsafe because the consequences of their actions will not affect their wages. If they were injured on the job, their wages will be covered under workers compensation.

Using workers compensation premiums or an accident tax to prevent workplace injuries as an alternative to OSHA regulations has been contemplated for years. However, the moral hazard associated with the use of workers compensation, may be incentive for employees to take additional risks (Moore & Viscusi, 1989). In addition, due to the demand for premium wages when working in highly hazardous environments, there is an incentive for employers to take safety precautions to make the jobs safer. In turn, this could limit the premium wages placed on jobs that are high risk and thus reduce their wages.

A study conducted by Campolieti & Hyatt (2006), tested the idea of moral hazard and its relationship to the *Monday Effect* in workers compensation. The *Monday Effect* is the large number of workers compensation claims filed on Mondays. Some believe that these claims are a result of non-work-related injuries. The study, conducted in Canada, ruled out the issue of lack of health insurance as a cause for the increased number of workers compensation claims filed on Monday because of the availability of universal

health coverage. They found that when comparing the Canadian data with previous studies in the United States, loss of earning may create an incentive to report claims and thus create an *ex ante* moral hazard. However, they go on to state that the number of claims may be due to physiological factors related to the rest period over the weekend (Campolieti & Hyatt, 2006).

In a study conducted by Bolduc et al., (2001) they also looked at how *ex* ante and *ex* post moral hazards affect workers compensation insurance. Their study reviewed panel data from Quebec Canada on the construction industry. In their analysis of the data, they found that a one percent increase in benefits would cause a 0.4 percent increase in difficult worker compensation cases. They concluded that these difficult workers compensation cases may be fraud or not related to the workplace.

The perceived moral hazard with worker's compensation insurance may explain the rationale behind the waiting period before wage replacement benefits begin. In many states, there is a mandatory waiting period before workers compensation benefits will replace wages. During this period, costs of the employees' medical expenses are covered. However, wages are not replaced until the employee meets this waiting period requirement. The waiting period is in essence a deductible that the employee pays through the loss of their wages. They must determine if reporting the injury or working in an unsafe manner is worth the loss of their wages (Hammer & Price, 2001).

In addition, Lanoie contends that regulatory policies such as OSHA actually do not improve safety because of the moral hazard (1991). Precautions that employees and employers may have taken without the regulations in place are not there. There is a sense that someone else is responsible for safety. In addition, if there is not a standard in place

that specifically identifies a hazard, then there is no need to take precautions. In the case of OSHA, the regulations are one sided and the adverse consequences are placed on the employer. The employer receives the citations and fines, not the employee. This regulation has a powerful influence on the behavior of the employer, without altering the behavior of the employee (Lanoie, 1991).

As with most regulatory agencies OSHA, utilizes deterrence theory. Deterrence theory attempts to ensure the consequence of an undesired action is such that it prevents the undesired action from taking place (McQuistion et al., 1988). In this theory, an undesired result or consequence occurs if there is a violation of the regulation. For deterrence theory to work, the sanction must be certain, severe, and swift to make the deterrence effective (1988). According to the General Accounting Office, penalties assessed by OSHA are a critical enforcement tool to deter employers from violating the standards (GAO, 2004).

However, there is an argument that the agency hardly serves as a deterrence factor and is not effective in making industry comply with the standards. In order for deterrence to work, there has to be a threat of an inspection and a substantial penalty. The effect of the deterrence theory is highly dependent on the expectation of the organization that they will be inspected and penalized (Gray & Scholtz, 1990). Many contend that there has been a systematic weakening of the OSHA Act and that the agency is not a deterrence factor in some organizations (McQuistion et al., 1988) thus, limiting the ability to deter unsafe workplaces.

A study conducted by Haviland et al. (2008_b), reviewed the impact of OSHA penalties on injury and illness rate reduction in Pennsylvania. They found that penalty

inspections began to reduce injuries starting in the 1990s. They attributed this to the use of programmed inspections that "began to target individual establishments, primarily in manufacturing, that had unusually high injury rates" (Haviland et al., 2008b). In essence, the agency was developing its list using site-specific data and inspecting the organizations where the most injuries were occurring.

Haviland et al. (2008b), acknowledge that in these cases it is possible for there to be regression to the mean, which indicates that rates may naturally reduce without intervention. The data used to make the inspection list are at least two years old by the time the inspection takes place, limiting the bias of regression to the mean. However, the research failed to mention that in 1991, OSHA increased penalty amounts. It is likely that the combination of site specific targeting and the penalty increase, enhanced the deterrence effect of the agency.

<center>Alternatives to the Agency</center>

The debate on the effectiveness of the agency has led to many alternative proposals that may have merit when it comes to occupational safety. Among the different proposals debated during the passage of the act was an accident-tax and workers compensation (Anderson et al., 1986; Mintz 1984). An accident tax would place a premium on each accident that occurred in the workplace. An accident tax is designed to encourage employers to be proactive in taking the necessary steps to prevent injuries. In addition, this could make an organization look at preventing injuries and illnesses that do not have a specific OSHA regulation. However, an accident tax system provides an incentive for employers and employees to underreport injuries (Lanoie, 1994).

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Nevertheless, an accident tax system could help the current system of workers compensation by linking outcomes, such as the prevention of accidents and claims, to the relative safety of the workplace. Lanoie focuses this argument by using a principle-agent model. In this model Lanoie states, "Both firms and workers can affect the risk of an accident and this risk may influence the negotiated wage." However, the drawbacks of this type of system are the incentive for the employer to underreport in an accident tax system and the employee to underreport in a safety bonus system (Lanoie, 1994).

Liability based systems may open up an opportunity for employers to coerce employees into not filing claims or use other methods of compensating employees. For example, an incident occurred with Chrysler in 1986 where they underreported their occupational injuries. In this case, the company underreported injuries in an attempt to prevent increased workers compensation costs and transfer the costs to their health insurer. Chrysler had the injured employees claim the injuries under their health insurance instead of the workers compensation insurance. When OSHA investigated and uncovered the scheme, they received a fine of $910,000 for their recordkeeping violations in addition to sanctions for insurance fraud (Clinard, 1990).

The workers compensation system has also been suggested as an alternative to OSHA enforcement. Workers compensation insurance is required by state governments and operates concurrently with OSHA. Employers must pay an insurance premium or have cash reserves in place to cover the cost of injuries. Employers with low injury and illness rates receive insurance at lower costs, giving them the incentive to create safe work environments (Hammer & Price, 2001). Employers with higher injury costs have a higher experience modifier and thus pay a higher premium for insurance. In addition, the

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industry type and occupation of the employee also account for the cost of the premium. Jobs that are high risk require a higher premium for insurance.

Workers compensation laws vary from state to state and are still driven at the state level. Each state determines how the laws are to be applied. There are variations between states about the waiting period before wages are replaced, the amount of compensation provided, and the employers' responsibilities. Some states require that employers have mandatory safety and health programs and safety committees while others have few stipulations (Smitha et al., 2001). Safety and health programs and safety committees are designed to prevent accidents and reduce costs for employers. There is some evidence that mandatory requirements for safety committees, safety programs, and longer waiting periods for benefits significantly reduce occupation injury and severity rates (Smitha et al., 2001). Safety programs and committees are thought to work in a proactive manner to prevent workplace injuries. However, issues related to waiting periods may actually cause the employee to underreport an injury and work injured in order to prevent loss of income during the waiting period.

The concept of workers compensation was designed to protect employers from employee lawsuits. Prior to workers compensation laws, which were passed state by state starting in 1911, employees had to take their chances in court. Common law doctrines at the time such as assumed risk, contributory negligence, and fellow servant rules did not place responsibility of occupational injuries or fatalities on the employer but on the employee (Goetsch, 2005). However, employees began to win lawsuits and employers needed a way to protect themselves from *windfall* judgments.

Once workers compensation laws were enacted, employers were held accountable to pay a premium related to their companies' injury history. After the passage of workers compensation laws, employees were granted compensation for medical expenses and lost wages. Injury rates declined because it was in the employers' interest to provide a safe work environment and prevent the pay out of workers compensation premiums (Rosner, 2000). The success of workers' compensation should work two ways to protect employees and to reduce costs to employees and employers (Goetsch, 2005). One of the ways that workers' compensation protects employees is that it prevents long court battles. Prior to the passage of workers compensation laws employees were on their own to pursue legal action to obtain restitution for their injuries (Goetsch, 2005; Hammer & Price, 2001). The compensation laws are "no-fault" laws that prevent employees from suing their employer. In addition, employers also see a reduction in costs with the use of workers' compensation. The employers will be proactive to prevent injuries and to reduce premiums. According to Goestch (2005), the cost savings are seen in the "legal, image, and moral costs." Workers compensation theoretically should have been enough to have employers self regulate and ensure a safe workplace. However, as stated earlier, workers compensation was not enough to reduce and or prevent workplace injuries, illnesses and fatalities.

Agency History

Understanding agency history will allow the context of decisions that were made within and for the agency to be understood. Although President Nixon is given credit for signing the OSHA Act into law and establishing the agency, the need for the act was seen well before his administration. The current era of workplace safety started with President

Lyndon B. Johnson who proposed an Occupational Health and Safety Law in 1968

(Mintz, 1984). During the administration of President Johnson, a comprehensive law was

proposed to protect workers. At that time, a statement from the Secretary of Labor

Willard Wirtz discussed how workers compensation laws had failed to protect workers.

Wirtz's question was "why had the free market not provided sufficient incentives for

businessmen to avoid accidents?" (Mintz, 1984). Despite worker compensation laws

that were in place at the time, the number injuries were still increasing.

Other factors were discussed during the congressional hearings leading up to the

passage of the act. In 1970, Secretary of Labor Shultz testified that 14,500 people were

killed annually because of industrial accidents. In addition, about 2.2 million people

were disabled each year because of injuries sustained on the job. The secretary argued

against using the free market concept or workers compensation to lower injury rates

because it had not worked. According to Shultz, this was apparent because rates were

20% higher in 1970 than they were in 1958 for workplace injuries and illnesses (Mintz,

1984).

In addition to the support from the Secretary of Labor, the Johnson

Administration looked at the occupational safety law as political capital. The Johnson

Administration used the idea of a safety law as a way to use "quality of life issues" to

enhance their social reform policies and to gain the interest and support of organized

labor (Eisner, 2000). However, the occupational safety bills presented during the

Johnson Administration failed to pass thus, leaving the regulation of occupational safety

on a national level to the Nixon Administration (Mintz, 1984).

President Nixon set occupational safety on his agenda and wanted a bill to pass. Nixon also did this as a way to show that he was interested social issues and like Johnson wanted to gather organized labor support. Support of the bill by Nixon and his fellow Republicans was about portraying an image of doing something for the "blue collar worker" (Mintz, 1984; Page & O'Brien, 1973). Regardless of the reason, the Nixon Administration supported the act and it was passed in December 1970.

There are many reasons why the OSHA Act passed. According to Ashford (1976) in his report to the Ford Foundation, the following factors helped to complete the passage of the OSHA Act. The first factor that Ashford discussed was based on data from the National Safety Council (NSC). In the years 1961 through 1970, NSC data showed a 29% increase in the injury rate. This data included 2.2 million disabling injuries annually and an estimated 14,000 deaths annually on the job. The second factor that Ashford discussed was that occupational diseases, which include things such as silicosis, asbestosis, and hearing loss, were not reflected in statistics collected by BLS or NSC (1976). This is often the case with occupational illnesses due to the long latency period between exposure and the onset of the disease and the difficulty of linking the disease to employment. Even today, occupational illnesses are difficult to track.

The third factor that Ashford contributes to the successful passage of the act is how rapidly technology was changing. This broad use of the term technology looked not only at mechanical improvements but also at the new chemicals being utilized, and the stresses that these technological changes were placing on the worker. The fourth factor that Ashford discussed was the rise in awareness of pollution due to the environmental movement. This awareness contributed to the rise in awareness of industrial pollution

and the affects of those working in the industrial environment and led employees to have concerns about exposures to chemicals used in the workplace. The fifth and final factor that Ashford discusses that contributed to the passage of the act included the change in the characteristics of the workforce. The workforce at that time was more educated, received higher wages, and was concerned and about their work environment (Ashford, 1976).

In addition, other factors allowed the act to pass. One of these factors was the need for a consistent method of enforcing workplace safety rules. The goal of the OSHA Act is "to assure safe and healthful working conditions for working men and women" (Public law 91-596, Dec 29, 1970). Up until that time, the burden of enforcing workplace safety regulations was placed on the states (Mintz, 1984). Some states used their own safety and health standards to protect employees in addition to requiring employers to have workers compensation insurance. Other states lacked safety regulations or a method of enforcing safety regulations.

Although there are numerous reasons why the Act passed, the act immediately became a source of contention between the business and government. The Act, which took effect in 1971, was a great milestone in the field of workplace safety. With the passage of this act, a small agency with the potential to affect almost every working person in the nation was created. Despite initial optimism of an agency that would protect *all* workers, OSHA has been described as one of the "most maligned federal agencies" (Elhassan, 2000).

In addition, many in business still thought that they could achieve occupational safety through voluntary compliance. During the testimony leading up to the passage of

the OSHA Act, statements such as those from Leo Teplow of the American Iron and Steel Institute against the use of a regulatory agency were representative of the thinking of the time. Teplow found the idea of an agency used to regulate workplace safety as intrusive. Even after the act was signed into law, many challenges remained for the agency. Numerous court cases disputed the implementation of new standards and the right of the agency to enter the workplace (Mintz, 1984). Issues such as lack of financial support, inept inspectors, and different methods of determining effectiveness have plagued the agency. There are many who believe that agency is not achieving its mission of preventing workplace injuries and is weak and in need of more regulations. Others feel it is an unnecessary burden to business and creates inefficiencies (Bartel & Thomas, 1985). Nevertheless, since the inception of the agency, safety in the workplace has made significant gains. Data provided by the Bureau of Labor Statistics indicate that in 2005 the total number of workplace fatalities was 5,702 (BLS, 2006). This is a large decrease in occupational deaths since 1970.

However, as with other social legislation of the time such as the Environmental Protection Act which established EPA, the passage of the OSHA Act did not immediately prevent every injury or illness, or ensure that every workplace was safe or in compliance. OSHA was given the complex task of preventing injuries and illnesses in a wide range of industries. Compounding this issue was that the agency had to work under constraints such as rule making, implementation guidelines, and court decisions (Eisner, 2000). Many of these constraints were in place to ensure that all of the stakeholders such as labor and employers had an opportunity for input. However, they became a tool to slow implementation of new standards. As quickly as OSHA was passed, there were efforts to

reduce or eliminate the agency. One of the ways that the agency is restricted is using riders on the appropriations bill. Many of these riders exempt particular industries from the Act or from specific standards (Eisner, 2000). As time progressed, the constraints seemed to err on the side of the employer and not the workers or public when discussing OSHA.

The two major stakeholder groups for OSHA, labor and employers, have both for various reasons often criticized OSHA. Consensus among many employers is that the regulations are ineffective and that OSHA is a burden to employers. Employees find that the regulations are not strict enough and that the process of new standard implementation is slow. However, this is not just an OSHA issue; this has been an issue with many regulatory agencies. As stated by *Eisner in Regulatory Politics in Transition* (2000), in reference to the establishment of OSHA and EPA.

> On the one hand, the complexity of the regulations issued by these agencies and the high costs of compliance with these regulations generated great corporate resistance. On the other hand, the time required to promulgate standards, a direct reflection of the complexity of the questions involved and the multiple layers of review, provoked constant criticism from the proponents of regulation. (p.135)

OSHA was given the difficult task of implementing standards that are broad enough to cover all workplaces. However, when doing this, the complexities of the processes are not considered and in some cases, hazards are not addressed. A common criticism of the agency is that the regulations do not prevent injuries and fatalities. In addition, the agency and its policies are shaped by the administration in charge.

History of Assistant Secretaries and Agency Policy

The Assistant Secretary of Labor for OSHA is the person designated to lead the agency. The Assistant Secretary is a political appointment who reports to the Secretary of Labor. The Assistant Secretary is responsible for all aspects of the agency and is charged with implementing the policies of the administration as they relate to the agency. The agency has three main organizational levels, the National Office, Regional Offices and Area Offices. The National Office focuses the agencies direction and is responsible for new regulations and policies. The agency is divided into ten regions with 10 Regional Offices. The Regional Offices support the Area Offices and ensure that National Office policies are implemented. The Area Offices are the lowest level in the organization. It is at the Area Office level where inspections originate.

In addition to establishing OSHA, the OSHA Act also established NIOSH to conduct research in occupational safety. NIOSH provides this service to OSHA and MSHA (Mine Safety and Health Administration). The Occupational Safety and Health Review Commission (OSHRC) was another entity that was established with the passage of the act (Eisner, 2000). The OSHRC is a three-member commission that hears contested OSHA cases.

Each Assistant Secretary has left their mark on the agency. The first Assistant Secretary for the agency was George Guenther. Guenther served as assistant secretary of labor for OSHA from 1971 to 1973 and oversaw the period in OSHA history known as the start-up phase of the agency. He was chosen for the position because of his experience with the Pennsylvania Department of Labor and Industry and his private sector manufacturing experience (MacLaury, 1984). One of the decisions made during

Guenther's reign as Assistant Secretary that ended up causing much controversy and chaos for the agency was the adoption of established consensus standards.

These consensus standards were adopted within the first month of the agency, even though the agency was given twenty-eight months to establish or adopt standards under the startup phase (Eisner, 2000). These consensus standards were developed by industry and consensus organizations as voluntary guidelines for processes and procedures. A problem with consensus standards were that they were written as voluntary guidelines with wording such as "the employer should" do something rather than the "employer shall" do something and could not be enforced, or had requirements that were not related to employee safety (Mintz, 1984).

This blind adoption of consensus standards is cited as the reason why the agency developed the reputation of being out of touch with safety issues. Although this allowed for immediate standards, these standards were described as being "outdated, irrelevant and extraordinarily detailed" and had little impact on the safety of the workplace (Eisner, 2000). These startup standards left problems for future Assistant Secretaries. However, the agency did make some advances on the occupational health front by passing a regulation on asbestos exposure by going through the formal rule making process.

In addition, during this period was the first time that the agency was used for political agendas. Although Nixon is credited for signing the act, the agency was also used to find support for Nixon's re-election. As stated earlier, the act was a way for Nixon to show concern for social issues. However, the agency was also used to coerce support through the responsiveness program that initiated inspections on companies who did not support the Nixon political campaign (Eisner, 2000).

Another issue that agency dealt with during the startup phase was finding qualified individuals to conduct inspections and manage the agency. In order to train inspectors, the agency established the OSHA Training Institute (OTI) in 1972 (www.osha.gov/as/opa/osha30yearsmilestones.html retrieved on 11/29/08). The primary purpose of OTI was to train inspectors on safety regulations and inspection techniques. In later years, OTI also developed training materials for the private sector.

The next assistant secretary of labor for OSHA was John Stender who served in that position from 1973-1975. During this period, more criticism of the agency began to emerge, with Congress at the forefront of this criticism. Critics openly voiced their concern that the agency was not meeting its goals of protecting the workforce. Members of congress, such as Senator Kennedy, wanted the agency to expand its staff and to issue more health standards to protect workers from occupational illness (MacLaury, 1984). Adding to the concern during Stender's reign as assistant secretary, were two occupational disasters that occurred and kept OSHA and occupational safety in the spotlight and led to much of the criticism. In February 1973, 40 workers were killed in Staten Island NY when a liquefied natural gas storage tank exploded. Then in March 1973, 12 workers were killed and 34 were injured when a building under construction collapsed near Washington D.C. (MacLaury, 1984). These tragic events showed both the need for OSHA and many of the shortcomings of the agency.

In addition, the agency began to lose support from the Nixon and Ford Administrations. There was pressure and backlash from industry groups about the numerous government regulations and burdens of those regulations. Due to this backlash, efforts were made to delay enforcement and implementation of OSHA

standards. However, during this period the agency also made efforts to fix the consensus standards that were adopted in the startup phase and make them usable.

The next Assistant Secretary for OSHA was Morton Corn, who served from December 1975 to January 1977. At this point, the agency had received much criticism from all groups. A report developed by Ashford (1976) discussed some of those criticisms and stressed the need to have a safety and health professional head the agency. Corn was a professor of Occupational Health and Chemical Engineering at the University of Pittsburgh and was the first safety and health professional to head the agency. The nomination and subsequent confirmation of Corn was well received by all groups because of his background in occupational safety (MacLaury, 1984).

Corn's focus was about occupational health issues related to OSHA and the professionalism of the staff. In addition, he wanted to implement the intent of the OSHA Act without "extraneous influences" (Eisner, 2000). These "extraneous influences" were mainly referring to political pressures intended to impede protecting the workforce. However, Corn was in a political environment and President Ford often cited OSHA as a symbol of overregulation and regulation gone array (Eisner, 2000). Once Ford was gone from office, Corn's tenure with the agency ended even though he was well received.

Eula Bingham became the Assistant Secretary for OSHA during the Carter Administration. Bingham came from the University of Cincinnati and had a strong background in occupational health. She was the first and only woman to head the agency and served during the entire Carter Administration. During the beginning of her tenure, Bingham was able to appease business and labor by developing "*The Shift to Common Sense Priorities.*" This booklet was developed by the Department of Labor and outlined

priorities for the agency with the intent of making the agency more "practical" (MacLaury, 1984).

With this agenda, Bingham set three priorities for the agency. The first priority was to work on occupational illnesses. The second priority was to add "common sense" to the regulations and to make a safe workplace without burdening employers. The third priority was to simplify the regulations. Although Bingham worked on each of these priorities, she focused on the first priority. During her time with the agency, she was able to set new standards on cotton dust, lead, benzene and worked on developing a carcinogen policy (Eisner, 2000). The intent of these standards was to protect workers from occupational health hazards. During her tenure at OSHA, Bingham was able to double the number of health standards (Eisner, 2000). In addition, the number of inspectors also increased under the leadership of Bingham. It was also at this point, where declines were observed in injuries and fatalities.

In an effort to alleviate some of the criticisms of the agency, Bingham started the "Standards Deletion Project." This project eliminated standards blindly adopted during the startup phase, which were not related to the mission of the agency. This "Standards Deletion Project" deleted about 600 standards by 1978 (Mintz, 1984). The rule making process had to be followed and which slowed the deletion process and used many resources of the agency (Eisner, 2000).

However, by 1978 the Carter Administration began to resist the regulatory agenda of the agency. Due to the poor economic conditions and a Brookings Institution study published in 1978 that stated that job safety and health laws cut productivity and growth, the Carter Administration slowed the development of new standards. In conjunction with

the previously mentioned reports and the decline in the economy, only one new occupational health regulation passed during the Bingham era after 1978(MacLaury, 1984).

The agenda in the agency took a dramatic turn with the election of President Reagan. During this period, the Reagan Republican Revolution and Regulatory Relief programs directed the focus of agency (MacLaury, 1984). The changes made under the Reagan Administration intended to limit the agency and to appease those who found the regulations burdensome. However, many saw the changes as detrimental to occupational safety and employees. As stated by Eisner (2000), "the Reagan appointees to OSHA reversed the gains of the late 1970s, seeking to further reduce the regulatory burden and forge a more cooperative relationship with business."

Thorne Auchter, appointed by Reagan to head the agency, oversaw the agency from 1981 to 1984. Auchter was an executive in his family's construction company and a campaign organizer in Florida. Ironically, he was appointed to the post even though his company was cited for numerous OSHA violations (Eisner, 2000). In the official history presented by the department of labor, Auchter is described as a hardworking assistant secretary who believed in the agency. Under his watch, the agency implemented the Integrated Management Information System (IMIS) to track the functions and efficiency of the agency (MacLaury, 1984). Auchter did this in an attempt to make the agency function more efficiently with the belief that the agency could be more proactive.

Auchter believed that the agency could obtain its mission by using a less aggressive and less adversarial approach. The changes on the enforcement end could be seen in "less punitive citations and penalties" and increased volunteer efforts on the part

of employers. However, with new cooperative approach there became a divide between unions, who were for strong enforcement, and employers, who wanted less government regulations. The goal of Auchter and the administration was to make the agency become a more "cooperative regulator," meaning that it looked to work with employers to implement safety standards. However, what many on the other side believed was this simply asking nicely if they would comply and if not, there were no consequences for their actions (Eisner, 2000).

Another policy implemented during Auchter's tenure was the cost-effectiveness analysis on the establishment and implementation of OSHA standards (Eisner, 2000). With this policy, prior to a new regulation being implemented it must be proven cost effective. The regulation must show that the cost of implementation is worth the lives saved. This policy was in contradiction with the act, because the act did not address cost-effectiveness. In essence, what Auchter did was create another criterion for the agency to meet before new standards were implemented.

In addition, the Auchter period also had the largest decline in OSHA staff. In 1980, the number of full time employees was about 2,915. In 1986, the agency reached a low of 2,166 full time employees. This reduction in staff was accomplished through an official reduction in force (RIF). This RIF was achieved by forcing certain OSHA field employees to change duty stations or lose their jobs. In many situations, the employee resigned and in others, the employee moved at the government's expense. What happened was a massive shuffle of employees and many hard feelings among career staff. The agency's career staff despised Auchter for this and for the perceived lack of

enforcement efforts, especially in the occupational health area. In addition, the funding for the agency was reduced (Eisner, 2000).

Auchter was successful in carrying out the agenda of the Reagan Administration. He effectively cut the staff, budget, and number of inspections during his tenure. Although, this was not the era with the least number of inspections, inspections were less than with the Carter Administration and overall penalty amounts were also lower. In addition, at the end of his tenure occupational injuries began to climb in manufacturing. This may have resulted from the perceived lack of enforcement and limited consequence of non-compliance. Nevertheless, Auchter did add efficiencies to the agency such as developing the IMIS system and establishing cooperative programs.

However, one thing that Auchter was not able to do was to prevent the industrial accident that took the life of his son. In a sad and somewhat ironic way, Auchter's implementation of less OSHA regulation may have had adverse consequences for his family. Auchter's son Kevin, then 22, was killed February 24, 2000 on a demolition job in Missouri. The company who he worked for was cited for two serious violations that totaled $14,000 in fines. Auchter later sued the contractors on the site and settled for $2.3 million (spewingforth.blogspot.com/2006/04/ex-osha-director-settles-lawsuit-over.html retrieved on 12/17/08).

After Auchter, the next person who was given the task of heading the agency was Robert Rowland. Rowland served in that capacity for less than a year and was a recess appointment, never confirmed by congress (www.osha.gov/as/opa/former_secretaries.html, retrieved on 11/23/08). Rowland was a Texas lawyer and a Republican fundraiser and former chair of the OSHRC (Eisner,

2000). However, his appointment and tenure as assistant secretary was met with much criticism because he owned stock in companies who were under OSHA jurisdiction and, as a former OSHRC member was very critical of the agency. Rowland was chosen for the job not only for his political connections but also because his philosophy about agency was similar to that of the Reagan Administration. This philosophy was one where the agency should be business friendly and focus on cooperation as opposed to enforcement. This included being non-adversarial, small penalties for violations, and few inspections (Davidson, 1990). However, Rowland was forced to resign because of alleged conflicts of interest (Isgro, 1985).

Although Rowland and the Reagan Administration were for limited government regulation, an influential standard for formaldehyde was implemented during his tenure. The implementation of the standard was not without resistance from the administration. In January 1985, the agency had rejected issuing an emergency temporary standard for formaldehyde. The basis of this decision was that there was no evidence of an "imminent grave danger" for the standard. Instead, the agency would go through its standard rule making process, which delayed protection for employees in industries that used formaldehyde (Noble, 1985). This rule making process can often be lengthy because of the time given for public comments and discussions of economic feasibility (Mintz, 1985). Nevertheless, the standard was implemented only after it went through the lengthy rule making process.

After Auchter and Rowland, the Reagan Administration chose, John Pendergrass became the Assistant Secretary of Labor for OSHA in 1986. Whoever took this position by this time was assured that they would be under severe scrutiny by labor and industry.

However, Pendergrass was a safety professional who stakeholder groups widely

accepted. He worked in industry and had a good understanding of health and safety

issues (Isgro, 1985).

Much like Corn and Bingham, Pendergrass was interested in protecting the

workforce and less concerned with politics. During his time with the agency,

Pendergrass attempted to update the Permissible Exposure Limits (PELs). PELs are the

limits that are set for air containments in the workplace. In reflecting on his career at

OSHA, he felt that his greatest accomplishment was updating the (PELs) (Laws, 2007).

However, these limits were repealed when the AFL-CIO and the American Iron and Steel

Institute sued the agency. These organizations sued OSHA because the standards were

not stringent enough. The resulting decision from the court vacated the new standards

and made the original standards the law. This decision required OSHA to go through a

lengthy rule making process for each contaminant. This decision is often cited as a

reason to change the way standards are developed and to streamline the standards making

process (Nash, 2000).

By the close of the Reagan Administration, there was pressure on the agency from

OMB, to enforce its standards and to meet its mission. As a result, there were some large

penalties issued. Under Pendergrass, OSHA imposed a $1.5 million penalty on Chrysler

in 1987 for hazards associated with lead and arsenic among others (NY Times, 1987).

This was in sharp contrast to the beginning of the Reagan administration where

enforcement efforts and large penalties were lacking. In addition, the injury and illness

rates started to decline near the end of the Reagan Administration.

Once Reagan left office, the agency saw some renewed interest from President George H.W. Bush. Bush did not completely continue the policies of the Reagan Administration as they applied to OSHA. The first Bush Administration allowed the agency to pursue new regulations on issues such as blood borne pathogens and cumulative trauma disorders (Eisner, 2000). In addition, Bush appointed Gerald Scannell as Assistant Secretary of Labor for OSHA. Scannell was in charge of the agency from 1989 to 1992. Many stakeholders respected Scannell because of his prior industry and government experience in occupational safety and his ability to work with all stakeholder groups (Eisner, 2000).

The next phase of the agency came with the Clinton Administration and the push for government reinvention to streamline federal agencies including OSHA. Joseph Dear was the Assistant Secretary of Labor for OSHA from 1993 to 1997. During his tenure, he oversaw the beginnings of government reinvention and efforts for OSHA to implement an ergonomics standard. Speaking to the American Society of Safety Engineers (ASSE) at their annual conference in June 1994, Dear outlined many of his objectives for the agency with the theme for reform of OSHA. He outlined the need for tougher enforcement, expanding cooperative programs, fixing standard setting, and government reinvention (Dear, 1994).

These statements were in following with the Department of Labor and OSHA's strategy to focus on the worst offenders and offenses. For OSHA, this meant looking at the employers who were injuring the most employees and who were in flagrant violation of the OSHA Act and its regulations. The second focus was to ensure the protection of vulnerable populations such as low-wage workers. The third focus was to deter

violations by issuing significant penalties and using the criminal statute of the act. This was to deter others from committing the same violations. OSHA did this by increasing the penalty amounts for willful violations and focusing on specific employers with high injury rates. The final focus was to get the results "swiftly and efficiently" (Dear, 1994). However, the government reinvention process intentionally or unintentionally slowed inspections and starting with the Clinton Administration the number of fatalities began to stagnate.

Although it is often thought that the Clinton administration was pro enforcement, there were times when the actions of the agency did not follow this pattern. For instance, 1996 had the least number of inspections for the agency since the start up year. It was in this period that many offices were taken off line for up to six months for "reinvention" training, thus limiting enforcement activities.

The next Assistant Secretary of Labor for OSHA was Charles Jeffress. Jeffress served in this capacity from 1997 to 2001 and came to the agency from North Carolina OSHA. He is credited with improving the state plan in North Carolina after the Imperial Foods Fire where over 20 employees lost their life because of blocked and locked exits. During his remarks at his swearing in ceremony, he emphasized the use the Cooperative Compliance Programs and enforcement on so-called "bad actors" (Jeffress, 1997).

During a Jeffress speech at the American Insurance Services Group 1998 Executive Conference, he stated that he wanted a Safety and Health Program standard and an Ergonomics standard implemented before he left office. Under a standard such as Safety and Health Programs, employers would be required to have a written safety health program. The program outlined by Jeffress had five key elements. These elements were

management leadership, employee involvement, hazard assessment, hazard prevention and control, and training (Jeffress, 1998). However, neither the Ergonomics nor Safety and Health Program standards have ever been implemented.

It was also during the Jeffress term the ill-fated Cooperative Compliance Program (CCP) started and ended. In this program, OSHA emphasized the cooperative part by assisting the employers with the worst injury records to improve their records through outreach and enforcement. This program had success on smaller scales in Maine with the Maine 200 program and in North Carolina (Jeffress, 1998). However, the Chamber of Commerce sued the agency and the program was stopped and eventually defeated. However, the agency still used site-specific data to develop inspection lists to target specific employers.

John Henshaw was the next assistant secretary and was received well by most stakeholder groups because of his background in occupational safety. John Henshaw served from August 2001 until December 2004. An industrial hygienist by trade, Henshaw oversaw safety at a chemical company. Henshaw's objectives when he entered office were to make OSHA a leader and model for safety and health. He wanted "strong, effective and fair" enforcement of the act. He also emphasized outreach programs such as education programs and consultation. Common themes that were found throughout speeches presented by Henshaw were partnerships, alliances, and VPP expansion (Henshaw, 2001). However, these programs are non-enforcement programs and critics of Henshaw often point to his focus on cooperative efforts as being detrimental to occupational safety. Although some policies were not well received by organized labor, he did assist and support the career staff.

Edwin Foulke, Jr. was the head of OSHA from April 2006 through November 2008. An attorney, Foulke once served on the Occupational Safety and Health Review Commission (OSHRC) who hears OSHA cases prior to them entering the circuit court system. In a speech given to the ASSE in June 2006, Foulke explained his agenda for the agency. In his speech, he again emphasized cooperative programs and voluntary efforts by employers. Missing from many of his speeches were enforcement efforts. Also discussed in his speeches were the efforts of the agency to work with the Department of Homeland Security on Pandemic Flu Preparedness. Foulke also discussed the promulgation of the Hexavalent Chromium standard as a major advancement of the Agency's agenda (Foulke, 2006). However, Foulke failed to mention that the hexavalent chromium standard was forced to be implemented by the courts and that it was the only new standard issued under the Bush Administration. Foulke left the post in 2008 to work for a law firm who represents corporations against OSHA violations.

Understanding the history of the agency is important to place the policies and compliance efforts into perspective. Each administration has tried to implement different agendas. Some of these agendas were strong on enforcement activities, while other focused efforts on cooperative programs. However, the concern with this research is how these changes in agenda affect occupational safety. Starting with the Clinton Administration and continuing through the Bush Administration, occupational fatalities have remained relatively unchanged. During this same period, the number of inspections have also held steady. When reviewing the budget during this period, it has slightly increased but has not seen large gains. In addition, staffing levels have been hovering around 2,100 FTEs.

Summary

Prior to OSHA, individual events have had a profound impact on safety standards, regulations, and enforcement efforts to protect the workforce. Catastrophic events often trigger new mandates and enforcement methods. Sometimes these regulations are implemented swiftly in response to public pressure without much thought to the extended consequences of the mandates. For instance, the Triangle Shirt Waist Company fire in New York City highlighted the need for fire safety (Rosner, 2000). Throughout OSHA's brief history, there have been numerous industrial accidents that could easily have been prevented. One of these accidents was the Phillips 66 explosion that killed 23 workers in 1989 at the Phillips oil refinery in Pasadena, Texas (Oil & Gas Journal, 1990). History repeated itself at the BP oil refinery in Texas City, Texas in 2005 when fifteen employees died and over 100 were injured during a maintenance outage at the plant. Both of these accidents could have been prevented if the established OSHA standard on Process Safety Management (PSM) was followed.

The attention given when there are major industrial disasters are helpful in placing the problem of occupational injuries, illnesses, and fatalities on the forefront of the regulatory and social agenda. However, occupational deaths and injuries happen on a daily basis. According to BLS, in 2007 there were 5,488 occupational related fatalities in all sectors. This equates to approximately 15 fatalities each day (BLS, 2008). In addition, there are millions of injuries and illnesses.

Nevertheless, the question of what is the best measurement of safety in the workplace and the effectiveness of OSHA remains. According to Anderson et al., (1986), all of the stakeholder groups (labor, employers, employees, and media) question

the overall effectiveness of the agency. Is the overall injury rate a good indicator of workplace safety or are workers compensation modification rates a better indicator of safety in the workplace? However, even with OSHA in place, occupational injuries, illnesses, and fatalities are still occurring and harming employers, employees and their families. Andre Levison illustrates this lack of awareness of the problem of occupational injuries with the following quote from *The Working Class Majority (1974):*

> Imagine for a moment the universal outcry that would occur if every year several corporate headquarters routinely collapsed like mines, crushing sixty or seventy executives. Or suppose that all the banks were filled with an invisible noxious dust that constantly produced cancer in the managers, clerks, and tellers. Finally, try to imagine the horror that would be expressed in every newspaper in the country if thousands of university professors were deafened every year or lost fingers, hands, sometimes eyes, while on their jobs. (p. 78)

These deaths do not seem to get attention from the public because the deaths occur one at a time and often do not appear to have a connection. However, these incidents are connected by occupational safety and health regulations promulgated by OSHA.

CHAPTER III

METHODS

Introduction

The purpose of this research is to determine if the Occupational Safety and Health Administration (OSHA) has had a moderating effect on occupational injuries, illnesses and fatalities while accounting for other factors that relate to occupational injuries, illnesses and fatalities. The mission of the agency is to "provide a safe and healthful working environment" (OSHA Act, 1970). This research was an attempt to determine if the agency is meeting its mission.

As stated earlier, this study attempts to answer the following research questions:

- Occupational injuries and fatalities have decreased since the inception of OSHA. Can this decrease be attributed to OSHA?

- How have workforce and economic factors affected occupational injuries and fatalities?

- Since the inception of OSHA, what is the relationship of the agency's budget, number of inspections, and number of inspectors to injuries and fatalities?

- After other factors have been accounted for, is there a detectable contribution from OSHA in the reduction of occupational injuries and fatalities?

- To what extent have data from the Bureau of Labor Statistics (BLS) and the National Safety Council (NSC) helped or hindered the understanding of occupational injuries and fatalities?

The following hypotheses were tested in this study:

H_1 The creation of OSHA has decreased occupational injuries and fatalities.

H_0 The creation of OSHA has no effect on occupational injuries and fatalities.

H_1 The numbers of OSHA inspections, inspectors, appropriations, political party, labor trends and economic indicators have a significant impact on occupational injuries and fatalities.

H_0 The numbers of OSHA inspections, inspectors, budget, political party, labor trends and economic indicators have no significant impact on occupational injuries and fatalities.

H_1 As the number of OSHA inspectors, inspections, budget amount, citations and penalties increase, there is a decrease in workplace injuries, illnesses and fatalities.

H_O There is no relationship between the number of OSHA inspectors, inspections, budget amount, citations and penalties and workplace injuries, illnesses and fatalities.

This study uses quantitative methods to determine if workplace injuries are significantly altered by OSHA agency factors, economic factors, and workforce factors. OSHA agency factors include variables such as the number of inspections, budgets, and number of inspectors. Economic factors include variables such as GDP and income. Workforce factors include variables such as the number of workers and amount of unionization.

Merterns (2005) identifies five steps in conducting research. I used these steps to design the research study. The first step is to identify the problem. In this study,

occupational injuries, illnesses, and deaths create an economic burden on industry and a social cost to society. There are millions of workers affected by these incidents every year in the United States. In occupational settings, many accidents may be predicted and workplaces can be controlled to prevent accidents (Guang-Xiang, 2001). OSHA was enacted to protect workers from injury, illness, and death on the job by setting and enforcing occupational safety and health standards. It is important to know if it has had an effect on reducing the number of injuries, illnesses, and deaths. If it has an effect, it is important to know why. These events reach far beyond the direct costs to the employee and company and result in stress on the social service system, strain on the family, and other intangible costs to society.

However when trying to determine if the agency has affected occupational injuries and fatalities, it is also important to determine what is the best way to measure the agency. Much of the research focuses on the overall number of workplace deaths and injuries. The standard way of determining injury rates is based on the number of injuries and fatalities and man hours worked. However, this may not be the best indicator of the effectiveness of the agency. Controlling for factors such as GDP, annual budget, wages and number of inspections and inspectors may also show changes in occupational injuries and fatalities. Utilizing these variables will also take into account the changing dynamics of the workplace. Gilleman and Pierce (2006), discuss how using outputs to measure workplace safety may also be needed to assess improvements in injury and fatality rates.

In the second step, the variables of interest are identified (Mertens, 2005). The independent variables include OSHA's annual budget, number of inspections, number of inspectors, and number of employees, union membership, and economic indicators. The

dependent variables are the numbers of injuries, illnesses and fatalities and their associated rates.

Independent Variables	Dependent Variables
• OSHA Inspections	• Occupational Fatalities NSC
• OSHA Inspectors	• Occupational Fatalities BLS
• OSHA Budget	• Occupational Injuries NSC
• Average Wages	• Occupational Injuries BLS
• GDP	
• Union membership	
• Number of employee	

The third step of the process is to identify the appropriate research participants (Merterns, 2005). This study will be limited to the injuries, illnesses and fatalities as defined by BLS or NSC as occupationally related. According to BLS, occupational injuries "are any injuries such as acute, fractures, sprains, amputations, and so forth that result from a work-related event of a single exposure in the work environment" (BLS bulletin 2592, 2007). An occupational illness is "any abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to factors associated with employment" (BLS Bulletin 2593, 2007). For a fatality to be recorded in the CFOI, BLS uses criteria to determine if the incident is work related. According to BLS, to be counted in the CFOI:

A work relationship exists if an event or exposure results in fatal injury or illness to a person: (1) ON the employer's premises and the person was there to work; or (2) OFF the employer's premises and the person was there to work, or the event or exposure was related to the person's work or status as an employee. (BLS Bulletin 2593, 2007)

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In the fourth step of the research, quantifiable data was collected (Merterns, 2005). The Bureau of Labor Statistic (BLS) has collected injury and illness data for many years. However, problems with the BLS data are that different collection methods have been used over the years. In addition, the comprehensiveness of the early data is also in question. In addition to the BLS data, the National Safety Council (NSC) has also collected data on occupational injuries, illnesses, and fatalities and has provided cost estimates of injuries. At times, the NSC and BLS have collaborated in this analysis and have come to a consensus on the numbers. However, they have also used different methods to determine occupational injuries and illnesses.

Additional variables were also collected from the OSHA website on the number of inspections, inspectors, and budget. The Bureau of Economic Analysis provided data on GDP and average wages. The Census Bureau is responsible for publishing Statistical Abstracts of the United States, which is a compilation of many of the statistics that are produced by numerous agencies within the federal government. These abstracts provide a valuable source of historical information.

This history of the agency is also important to understand and review. This review is used to explain some anomalies that are found in the inputs and outputs in the data. For instance, if there is little or no change in injuries or fatalities during the first few years of OSHA, this may be due to the start-up phase. According to Mintz (1984), the agency was given two years to adopt "start-up" standards. In addition, there have been numerous court decisions that have shaped the operation of the agency. For instance, the Barlow decision requires OSHA to obtain a warrant to conduct an inspection when an employer requests a warrant (Marshall v. Barlow's, Inc., 1978).

Data analysis is the final stage that Mertens (2005) describes. The data was analyzed using multivariate regression analysis. The model uses an ordinary least squares (OLS) regression to determine the relationship with the variables. An example of the model in the general form is as follows.

Model:

Occupational fatalities and injuries are a function of the number of inspectors, number of inspections, OSHA budget, average wages, NSC injury costs, economic indicators, unemployment, union membership, and employment rates.

$$Y = constant + \beta_1 x_1 + \beta_2 x_2 + \beta_i x_i + \varepsilon$$

Occupational Fatalities $= \alpha + \beta_1(inspectors) + \beta_2(inspections) + \beta_3(budget) + \beta_4(avewage) + \beta_5(NSCcosts) + \beta_6(econind) + \beta_7(union) + \beta_8(employment) + \varepsilon$

Occupational Injuries $= \alpha + \beta_1(inspectors) + \beta_2(inspections) + \beta_3(budget) + \beta_4(avewage) + \beta_5(NSCcosts) + \beta_6(econind) + \beta_7(union) + \beta_8(employment) + \varepsilon$

Where:

Inspector   = the number of inspectors for the given year

Inspections   = the number of safety and health inspections for the given year

Budget   = the amount of money appropriated to operate the agency adjusted to 2001 dollars

Avewage   = the average wage of all employees in the United States adjusted to 2001 dollars based on BLS data

NSCcosts = the cost estimates developed by the NSC on the costs of
occupational injuries adjusted to 2001 dollars

Econind = the GDP based on the BEA numbers

Union = percentage of workforce who are union members

Employment = number of employed persons in the U.S.

These variables were chosen in order to control for economic factors, agency factors, and employment factors. Knowing the number of inspectors will show the commitment of the agency to the inspection process. Since the agency works on deterrence, more inspectors may indicate a greater deterrence effect. In addition, variables such as the number of inspections and budget could also indicate how resources are utilized and allocated. Increases in inspections and budgets may also show an increase in the deterrence effect and thus reduce injuries and fatalities. However, increases in inspections could also show a reaction to injuries and fatalities.

Average wages are included as a variable because higher wages may indicate higher hazard jobs. However, higher wages may also include things such as high technology jobs. A lower average wage may also show that there are more service sector jobs, which are low hazard. GDP was chosen to control for economic factors that may be influencing occupational safety. Comparing fatalities and injuries to GDP over the period in this study will give another dimension and method of measuring occupational safety. If GDP increases greatly and fatalities decrease, this may indicate that the workplace is becoming safer. However, if injuries and fatalities rise and fall with GDP, workplace safety may not be improving.

Employment statistics were also considered in this research. If there are more people working and less injuries and fatalities, the overall rate will fall. However, if the rates increase or decrease in proportion with the number of people employed, this may show that the rates have actually stagnated and that occupational safety has not improved. Union membership was also used as a variable in this study. There are indications that union job sites have fewer injuries than nonunion site. This study used the overall union membership to compare to the overall injury and fatality incidents.

<p style="text-align:center">Limitations of Occupational Injury Data Collection</p>

This study used available data for the analysis that was retrieved from sources such as BLS, NSC, Census Bureau, Bureau of Economic Analysis and the OSHA web site. However, as with any use of available statistical data there are limitations. According to Monette et al., (2005) in reference to available statistical data, they were complied to meet the needs of whatever agency, organization, or researcher originally collected them and in the form in which the data were collected limits the analysis" (p. 196). In this study, there were issues related to the change in collection procedures for fatality data.

The current BLS system known as the Census of Fatal Occupational Injuries (CFOI) used to count fatalities was started in 1992. The CFOI was a response to recommendations from groups such as the National Academy of Sciences to conduct a census to determine the aggregate number of workplace fatalities (Drudi, 1997; Roseman et al., 2006). In the United States prior to the CFOI, BLS had relied on surveys to calculate the number of workplace fatalities. The CFOI yields a more refined estimate by

using multiple source documents to determine the actual number of workplace fatalities. However, despite improvements that the CFOI has made in estimating occupational fatalities, other research has estimates that show greater numbers of workplace fatalities. This indicates that there are still discrepancies in the collection of data and the comprehensiveness of such data. One of the reasons for this is the counting of fatalities due to occupational illnesses. Occupational illnesses such as asbestosis, silicosis, and occupationally related cancers often take years to manifest and are not counted with the CFOI (Herbert & Landrigan, 2000).

The comprehensiveness of the time-series data gathered by the BLS has been questioned. Since the inception of the BLS, attempts were made to collect injury and illness data. In 1907, the director of BLS proposed that all states should collect data on occupational injuries and illnesses. In 1910, BLS started to issue an annual report of injury rates in the iron and steel industry (Drudi, 1997). This study focused on how owners, management and employees could affect injuries in the workplace (Chaney, 1922). Although the iron and steel industry was regarded as a dangerous industry, many other industries where occupational injuries and deaths occurred were left out of this study. In 1926, BLS collected data on several industries and by 1966, data were collected for over 650 different industries. However, in 1970, only 14 states participated in the Bureau's comprehensive statistics program (Drudi, 1997).

The National Safety Council (NSC) has also collected data on occupational injuries. The NSC and BLS reconciled their reported numbers with each other from the late 1930s until 1965 to come to a consensus on the number of fatalities (Drudi, 1997). In 1965, BLS started to use its survey-based fatality data only and no longer collaborated

with NSC. However, NSC continued to gather data from its multiple sources. Then in 1992 when BLS started the CFOI, NSC also adopted the CFOI numbers for fatalities excluding homicides and suicides (otherwise known as intentional acts) for their data (Drudi, 1997). Both systems acknowledge that their counts may or may not reflect the actual number of workplace injuries and fatalities. Although there are issues with the data, information from BLS and NSC are widely accepted as good indications of the number of injuries and fatalities.

Drudi, (1997), discussed the history of data collection related to workplace injuries and the BLS. Table 4, lists many of the events related to BLS and its predecessors on the collection of occupational injury data. This information is compiled from the research provided by Drudi (1997). As can be seen from the table, it was not until the passage of the OSHA Act that data on occupational injury and fatalities were mandated to be collected by BLS. In addition, the table also shows attempts prior to the passage of the act to collect data on workplace injuries and fatalities.

Table 4- *Timeline of Data Collection by BLS*

- 1884- President Arthur signed bill creating Bureau of Labor
- 1907- Arthur Reeves, commentator, unsuccessfully proposed that States report incidents to BLS
- 1909- BLS study of phosphorous poisoning
- 1910- BLS began annual report on iron and steel industry injury rates
- 1914- Royal Meeker 3rd Commissioner for the Bureau; wanted the Bureau to provide best practices to prevent injuries and fatalities (unsuccessful)
- 1926- BLS started annual survey on frequency and severity of injuries for manufacturing sites
- 1930- BLS annual survey covered ¼ of the workforce in 30 industries
- 1939- BLS survey also included fatality data
- World War II- data published on important wartime industries
- 1966-data published for 650 industries
- 1970- 14 states were participating in the Bureau's safety and health statistics program
- 1970- OSHA Act passed mandating the collection of Occupational Injury and Illness data
- 1976- Janet Norwood 10th Commissioner started the Survey of Occupational Injuries and Illnesses
- 1977-BLS initiated detailed studies on causes of workplace injuries called Work Injury Reports
- 1984- BLS received appropriated funds from congress to study injury and illness statistics- resulted in a redesign of statistical program
- 1992- Census of Fatal Occupational Injuries (CFOI); system used today by BLS

Other Sources of Injury Data

BLS data are often criticized for having inaccurate counts of the injuries sustained in the workplace (Stout & Bell, 1991). Prior to the Census of Fatal Occupational Injuries (CFOI), the system for collection relied on self-reporting of occupational diseases,

fatalities from death certificates (Baker et al., 1989). Data that rely on self-reports have an inherent disadvantage when the notion that reporting will cause additional adverse actions. Some of the reason why the BLS data may be incomplete is the perception of financial and/or regulatory action such as inspections of employers who are submitting the information (Roseman et al., 2006).

In addition, there are other sources of injury and fatality data available. One of these sources is the National Traumatic Occupational Fatalities Surveillance System (NTOF) (Guang-Xian, 2001). The NTOF system was administered by the National Institute for Occupational Safety and Health (NIOSH) and uses information from death certificates and other sources to determine the number of work-related deaths. The NTOF was started in 1980 and went until 1995. The NTOF was viewed as an improvement to the old BLS survey used to determine the number of workplace deaths (Bena et al., 2004). However, with time-series data, if the undercounts are consistent they may be detected.

Another issue that has placed concern on the accuracy of the BLS data is that the companies are required to self-report the information to BLS. In addition to the usual problems with self-reporting, OSHA uses the data for targeting specific industries and site-specific inspections thus, injury and illness rates affect when an establishment will be inspected which gives establishments an incentive to underreport their injuries and illnesses. Ruser and Smith (1990) discussed this issue when they conducted their research on the effectiveness of OSHA.

In addition, other systems have been proposed to track occupational diseases. One of these systems developed by NIOSH, encourages states to track six conditions

related to occupational illnesses. This system, known as the Sentinel Event Notification System for Occupational Risks (SENSOR), was designed as formal way to evaluate, the issue of occupational diseases. This method was to be used to determine the number of deaths associated with occupational diseases (Baker, 1989). However, the SENSOR system was short lived and was not in place throughout the history of OSHA.

This dissertation attempts to reconcile occupational fatality statistics in order to develop a consistent time-series. This consistent time-series will permit evaluation of the effectiveness of OSHA on occupational fatalities. The development of a consistent data set for occupational fatalities is necessary for evaluating the effectiveness of the agency. In addition, this research used available injury and illness data to evaluate the effectiveness of the agency.

CHAPTER IV

DATA AND ANALYSIS

Introduction

The reduction of occupational injuries, illnesses, and fatalities were the reasons that the OSHA Act was passed. There were concerns at that time that industry was not able to self regulate and prevent or reduce these events. The act gave OSHA the task of developing and enforcing regulations related to occupational safety. These regulations were to reduce the number of fatalities, injuries, and illnesses. However, there is controversy as to the agency's effectiveness in reducing those events.

Multiple influences may affect occupational injuries. Three categories of factors that may help to resolve some of the questions surrounding the effectiveness of OSHA are agency factors, economic factors, and workforce factors. Agency factors measure how the operation of the agency affects occupational injuries. Economic factors assess how GDP affects occupational injuries. Workplace factors capture how changes in demographics of the workforce affect occupational injuries. Evaluating the agency by taking into account all of these factors will allow a better assessment of the agency than simply looking at overall injury statistics.

As discussed in Chapter III, there have been multiple studies conducted on the effectiveness of OSHA. Many of these studies have conflicting or inconclusive results on the effectiveness of the agency. The following table summarizes some of the studies and their findings.

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Table 5. *Summary of Select Literature and Findings*

Study Authors & Title	Study rationale	Findings
Davidson, Worrell and Cheng, 1994	Are stock prices and residual owners adversely affected by OSHA inspections? If residual owners are affected, they will pressure management to ensure a safe workplace.	Shareholders are not affected by the announcement of penalties and do not place pressure on management to ensure workplace safety.
Bartel & Thomas, 1985	Evaluated two hypothesis using data from 1974-78. Agency is ineffective because of budget issues; OSHA Act is flawed because of lack of resources and will not help safety of a company	OSHA budget needs to be bigger for the act and the agency to be successful.
Brown et al. 2005	Study conducted in a steel plant to determine cause of injuries.	Found that accidents are complex and are sometimes related to production pressures.
Gray & Jones 1991	Using data from 1972-1983, wanted to determine if subsequent inspections reduced the number of citations.	Found the number of citations declined in subsequent inspections.
Ruser & Smith, 1990	Study focused on manufacturing establishments and the effect of inspections on injury rates.	Found little evidence to support that inspections reduced injuries.
Mendeloff & Gray, 2005	Study focused on how OSHA inspections reduced injuries.	Found that OSHA inspection reduce injuries in smaller firms (<250). However, inspections had little effect on firms >250 employees.
Suruda et al, 2002	This study evaluated the implementation of the trenching standard to determine if it reduced injuries and fatalities.	They found that there was a 66% decline in the number of trenching fatalities.
Seong & Mendeloff, 2004	Used the regulatory impact analysis report that predicts the benefits of a new standard and compared it to the actual results.	They found that the predictions were greater than the actual results. Thus, standards are not as effective as first thought.

Baker & Scherer, 1997	They wanted to know if there were significant differences in union firms vs. nonunion firms. They looked at the construction industry.	They found that union firms had less injuries and serious citations.
Bailer, Reed, & Stayner, 1997	Evaluated fatalities (1983-1992) in the forestry and fishing industry because of the high fatality rate.	They found that there was no significant decrease in the number of fatalities in these industries.
Gleason & Barnum, 1976	Wanted to know how penalties affected employers' stance on complying with the regulations.	They found that since the penalties were so low, it was easier and more cost effective to pay the fine than comply with the regulation.
McQuistion, Zakocs & Loomis, 1988	Evaluated OSHA's how inspections with penalties affect injuries.	Found that the deterrent effect of OSHA is working and that the agency needs resources to maintain deterrence.

As is highlighted in this table, many factors could potentially affect the success of the agency. One of the factors, resource sufficiency, deals with the agency itself. The agency uses deterrence to ensure compliance with standards, which in turn should reduce occupational injuries, illnesses, and fatalities. As discussed by McQuiston et al., 1988, in order for deterrence to work, the agency must maintain its resources. In essence, it must have a budget and staff large enough to conduct inspections, create standards and issue penalties to meet its mission. In addition, the penalty must be significant enough to get the attention of management. As was discussed by Gleason & Barnum (1976), the penalties must be high enough to deter noncompliance or they will be wrapped into the cost of doing business and will not cause the organization to make the facility safer.

Other potential influences on occupational injuries and fatalities are economic factors. In the studies reviewed, GDP did not appear as an explicit variable. A few studies discussed that production demands, positively associated with GDP, may have an

impact on workplace safety (Brown, et al., 2005; Suruda et al., 2002). Concluding that as production demands increase, there is an increase in injuries due to extended hours and influx of new employees.

In addition, other factors evaluated in the review of the literature were workforce factors such as unionization. A study conducted by Baker and Scherer (1997) evaluated the construction industry and the number of injuries and OSHA violations reported. In their study, they found that union firms in construction had a lower injury rate and did not receive as many serious OSHA violations. This may indicate that organized labor also has an impact on workplace safety. Thus, higher rates of unionization may enhance overall occupational safety.

There were studies that showed that OSHA had a large and significant impact on preventing workplace injuries and fatalities. For instance research conducted by Suruda et al. on the trenching and excavation standard showed, that there was a 66% decline in the number of fatalities in that industry after the trenching standard was implemented (2002). This would indicate that the trenching standard and OSHA were effective in reducing the number of occupational fatalities in that industry and shows that the standard and OSHA are effective.

However, other studies have shown little or no change in the number of workplace injuries and fatalities. Bailer et al. (1997) studied two industries that have a high number of occupational injuries and fatalities, fishing and forestry and found little evidence to show that OSHA is effective in reducing injuries and fatalities in these industries. In addition, Ruser and Smith (1990) found that there was "little evidence to

suggest that OSHA inspections in the early 1980s were effective in reducing the lost workday injury rate."

The literature reviewed identified and alluded to different factors that may influence workplace safety. One of the major factors is dealing with the influence of OSHA and agency factors on occupational injuries and fatalities. Another factor identified was how production demands affect workplace safety. The third factor indentified was how employee factors such as number of employees and unionization affect workplace safety. Drawing on the previous research, this dissertation used the combination of three broad factors to determine the effectiveness of OSHA. These agency, economic, and workforce factors will enable a review of OSHA effectiveness within the complex environment in which it exists. As with any occupational injury or fatality, there are multiple reasons or factors, which caused it to occur. The same can be said about the effectiveness of OSHA. There are multiple factors that affect the effectiveness of the agency and its ability to meet its mission.

<center>Research Questions</center>

To answer the primary research questions a database was constructed using agency, economic, and workforce factors to determine OSHA's effectiveness in reducing occupational fatalities and injuries and illnesses. Multiple government documents and other literature sources were used to create this database. Data were collected and analyzed to detect agency factors, economic factors, and workforce factors and their impact on occupational fatalities and injuries.

Analysis of the database was used to answer the following research questions.

- Occupational injuries and fatalities have decreased since the inception of OSHA. Can any of this decrease be attributed to OSHA?

- How have workforce and economic factors affected occupational injuries and fatalities?

- Since the inception of OSHA, what is the relationship of the agency's budget, number of inspections, and number of inspectors to injuries and fatalities?

- Has OSHA had a statistically significant impact on reducing occupational injuries and illnesses or are other factors responsible for the observed decrease in occupational injuries and illnesses?

- How have the number of inspectors, appropriations, political party, and economic factors influenced the number of occupational injuries and fatalities?

- To what extent have data from the Bureau of Labor Statistics (BLS) and the National Safety Council (NSC) helped or hindered the understanding of occupational injuries and fatalities?

Development of the Database

Multiple variables were used to build the database, answer the research questions, and to test the hypotheses. Data were collected by year on injuries, illnesses, and fatalities. The three sources of information for occupational fatalities were Bureau of Labor Statistics (BLS), National Safety Council (NSC), and National Institute of Occupational Safety and Health (NIOSH). A historical search of the National Safety Council publication Accident Facts and Injury Facts was used to collect NSC fatality data, injury and illness data, and cost data. Cost data from NSC were converted to 2001

dollars using the CPI calculators. This allowed for comparison of the costs of occupational injuries over the period of the dataset. BLS was used as a source for data on occupational injuries and illnesses and fatalities. In addition, BLS also publishes the Current Population Survey (CPS), which was a source of economic and demographic data on population, workforce, and median household income.

Another source of historical information is Statistical Abstract of the United States, which is published annually, and was used to collect injury, illness, and fatality data prior to the passage of the OSHA Act. The chapter on "Labor" in each year of Statistical Abstracts of the United States was reviewed and data such as number of occupational fatalities and injuries were placed into the database.

Information was also collected from OSHA and Department of Labor (DOL) on agency factors such as budget, inspections, inspectors, and penalties. A reported titled 20th *Century OSHA Enforcement Data* was a good source of information for the first 28 years of OSHA (Sisking, 2002). The penalty information in this report came from the OSHA IMIS (integrated management and information system) system. Penalty information from 2000-2007 was obtained from AFL-CIO in a report that also used the IMIS system as the source of the information. In addition, to make penalty amounts comparable, the CPI inflation calculator was used to convert the penalties to 2001 dollars.

Information on NIOSH NTOF (National Traumatic Occupational Fatalities Surveillance System), which contains NIOSH fatality data from 1980-1995, was extracted from a NIOSH report titled *"Fatal Injuries to Civilian Workers in the United States, 1980-1995"* (Marsh & Layne, 2001). This report discussed the use and development of NTOF and the number of fatalities reported. Fatality data from the

NTOF, along with NSC fatality information allowed the estimation of the workplace fatalities.

The following is a list of variables and descriptions that were used to detect agency factors, economic factors, and workforce factors effects on workplace injuries and fatalities.

Table 6. *List of Major Variables and Descriptions*

Year	Year
NIOSHEST	This is the estimated number of annual workplace deaths using the NSC and NIOSH information and the following formula NIOSH estimated deaths = -1360.0813260 + 0.6492379(NSCDeaths) + 3315.7718668(SHIFTDUM)
INJURIES_BLS	BLS number of occupational injuries in millions
INJRATEMFG	BLS injury rate per 1 million hours worked for manufacturing-prior to 1970
INJRATEMFG	BLS injury rate per 1 million hours worked for manufacturing; used prior to the passage of the OSHA Act.
INJRATECONST	BLS injury rate per 1 million hours worked for construction; used prior to the passage of the OSHA Act.
OSHARATEMFG	BLS injury rate based on 100 workers working 200000 hours per year. This became the normal way to report injury rates after the passage of the OSHA Act.

OSHARATECONST	BLS injury rate based on 100 workers working 200000 hours per year. This became the normal way to report injury rates after the passage of the OSHA Act.
OSHASTAFF	Number of OSHA full time equivalent employees (FTEs), including all inspection and administrative staff
FEDOSHAINSP	The number of federal OSHA inspections in the fiscal year
OSHABUDGET	The OSHA budget for that year adjusted to 2001dollars using the CPI inflation calculator
NSCCOSTS	The costs of occupational injuries reported by NSC adjusted to 2001 dollars using the CPI inflation calculator
CIVILIAN_WORKFORCE	BLS civilian workforce employed in millions taken from the Current Population Survey (CPS)
POPULATION	Number of non-institutional population from the CPS
FEMALE_POPULATION	Number in thousands of female non-institutional population
FEMALE_EMPLOYED	Number in thousands of females in civilian labor force
OSHA_DUMMY	dummy variable 0 = years before 1972; 1 = years after & including 1972
GDP_2001	GDP adjusted to 2001 dollars using the CPI inflation calculator
UNION	Number of union members (Mayer)
PERCENTUNION	Percentage of union member using (Mayer)
PENALTIES	Penalty amount for OSHA violations adjusted to 2001 dollars. Years 1972-2000 using IMIS data base (Sisking,

	2002). Years 2000-2007 were from AFL-CIO table using IMIS database.
PEN_DUMMY	Variable used to account for the 1991 increase of penalties. 0 = years prior to increase and 1=years after increase.
INCOME	Median household income obtained from CPS based on 2007 dollars.
NSC_COSTS	Cost of occupational injuries obtained from NSC and adjusted to 2001 dollars.

Creating a Consistent Time-Series for Occupational Fatalities

Multiple research questions were outlined in Chapter III, in an effort to determine if OSHA has had an impact on occupational injuries and fatalities. The first research questions asked was to what extent could the observed decrease in injuries and fatalities be attributed to OSHA? In order to determine if OSHA has had an impact on the number of fatalities, a consistent data set indicating the number of fatalities had to be established. However, as noted in Chapter III, BLS and NSC significantly changed reporting criteria in 1992. This change, although clearly identified by BLS is often missed when data are reported about trends in occupational fatalities. In order to establish if agency factors, economic factors or workforce factors have had an impact on occupational fatalities, a consistent time-series data set needs to account for this change in data reporting criteria. An occupational fatality time-series was created to account for this change by reconciling the NSC and BLS reports of occupational fatalities using the NIOSH NTOF.

Method Used to Develop Time-Series

As outlined in previous chapters, there has been much criticism of the way BLS counted occupational fatalities. Three major organizations, the National Safety Council (NSC), Bureau of Labor Statistics (BLS), and the National Institute of Occupational Safety and Health (NIOSH) have reported the number of occupational fatalities. Each organization has at different times used different methods of collecting information on occupational fatalities. Until 1992, BLS and NSC did not always agree on the number of occupational fatalities. In 1992 that changed with the implementation of the BLS Census of Fatal Occupational Injuries (CFOI). This census-based method of determining the number of occupational fatalities was a result of lobbying from the various groups such as NIOSH (Drudi, 1997). As a result, BLS stopped using their previous survey method of counting occupational fatalities and developed the CFOI. NSC then adopted the CFOI as the definitive number of occupational fatalities. The only variation between the two organizations is that NSC removes intentional acts from the count of fatalities (Drudi, 1997). Even though the CFOI is a superior method of counting occupational fatalities, this made the information reported by BLS and NSC after 1992 not comparable with previous years thus, preventing an available data set from NSC or BLS that was comparable from the beginning of OSHA through to present times.

In addition, National Institute of Occupational Safety and Health (NIOSH), the research agency created with the passage of the OSHA Act, developed their own system of accounting for occupational fatalities from 1980-1995. This was done partly to improve upon the survey approach used by BLS and to show that there were better methods to count occupational fatalities. The NIOSH system, known as the National

Traumatic Occupational Fatalities Surveillance System (NTOF) used multiple source

documents to determine the number of fatalities (Marsh & Layne, 2001). Although not

entirely the same, the NIOSH NTOF is similar to the CFOI in using a multiple source

document model to obtain the number of occupational fatalities. The NTOF overlaps the

old NSC system used prior to 1992 and the new NSC system, which adopted the CFOI

without intentional acts. This overlap allowed a regression model to be developed to

estimate the number of occupational deaths and develop a time-series that could be

account for the 1992 change.

This also allowed an estimated time-series to be developed for years prior to

OSHA. Since NSC had collected occupational fatality data in the years prior to the

OSHA Act and prior to BLS's requirement to collect data, the time-series developed

could be extended to the years prior to OSHA. This allowed for analysis of occupational

fatality data prior to OSHA and created a time-series that could be used to determine the

impact of the agency on occupational fatalities.

An OLS regression was conducted with NIOSH NTOF data from 1980-1995, the

NSC deaths from 1980-1995, and a dummy variable. The dummy variable was given a

value of zero for the years 1980-1991 and represented the data prior to the use of the

CFOI. The dummy variable was given a value of one for the years after 1992 and

represented the use of the CFOI by NSC and BLS. The NIOSH NTOF data were used

because of the overlap between the old and new BLS and NSC systems and used many of

the same source documents as the BLS CFOI system. The NSC data were used because

it had data prior to the establishment of OSHA and the mandate for BLS to collect

occupational injury and fatality data as outlined in the OSHA Act. Using these variables resulted in the following model:

NIOSHEST = -1360.0813260 + 0.6492379(NSCDeaths) + 3315.7718668(SHIFTDUM)
(tail prob.)   (.088)   (.000)   (.000)
R^2 = .917   n=16   SEE = 200.816   D-W= 1.727
R^2-adj.= .904
Where,

NIOSHEST   = estimated number of occupational fatalities

NSCDeaths_1980_1995   = number of occupational fatalities as reported by NSC

SHIFTDUM   = dummy variable 0 = years 1928-1991; 1 = years 1992-
                         2005

The output from this model indicates that the fit is reasonably good and that there is an acceptable Durbin-Watson statistic, which indicates that autocorrelation is not an issue. The equation developed from this output was used to establish a time-series that reconciles NSC and BLS data and creates the NIOSH Estimated Deaths variable.

Using the model and equation above, the estimated numbers of NIOSH deaths were established. Using an Excel template, the new variable Estimated NIOSH Deaths (NIOSHEST) was calculated. Table 7 shows the estimated number of NIOSH deaths using the above formula; the actual number reported deaths by the NSC and the actual numbers from the NIOSH NTOF. For the remainder of this study occupational fatalities will refer to the Estimated NIOSH Deaths calculated from this model.

Table 7. *Estimated NIOSH Deaths*

Year	NSC Reported Deaths NSC	NIOSH Reported Deaths	Estimated Deaths		Year	NSC Reported Deaths	NIOSH Reported Deaths NTOF	Estimated Deaths
1928	19,000		10,975		1967	14,200		7,859
1929	20,000		11,625		1968	14,300		7,924
1930	19,000		10,975		1969	14,300		7,924
1931	17,500		10,002		1970	13,800		7,599
1932	15,000		8,378		1971	13,700		7,534
1933	14,500		8,054		1972	14,000		7,729
1934	16,000		9,028		1973	14,300		7,924
1935	16,500		9,352		1974	13,500		7,405
1936	18,500		10,651		1975	13,000		7,080
1937	19,000		10,975		1976	12,500		6,755
1938	16,000		9,028		1977	12,900		7,015
1939	15,500		8,703		1978	13,100		7,145
1940	17,000		9,677		1979	13,000		7,080
1941	18,000		10,326		1980	13,200	7,343	7,210
1942	18,000		10,326		1981	12,500	7,061	6,755
1943	17,500		10,002		1982	11,900	6,378	6,366
1944	16,000		9,028		1983	11,700	5,784	6,236
1945	16,500		9,352		1984	11,500	6,113	6,106
1946	16,500		9,352		1985	11,500	6,192	6,106
1947	17,000		9,677		1986	11,100	5,624	5,846
1948	16,000		9,028		1987	11,300	5,813	5,976
1949	15,000		8,378		1988	11,000	5,710	5,782
1950	15,000		8,378		1989	10,900	5,679	5,717
1951	16,000		9,028		1990	10,100	5,384	5,197
1952	15,000		8,378		1991	9,800	5,219	5,002
1953	15,000		8,378		1992	4,968	5,032	5,181
1954	14,000		7,729		1993	5,034	5,286	5,224
1955	14,200		7,859		1994	5,338	5,406	5,421
1956	14,300		7,924		1995	5,015	5,314	5,212
1957	14,200		7,859		1996	5,069		5,247
1958	13,300		7,275		1997	5,160		5,306
1959	13,800		7,599		1998	5,117		5,278
1960	13,800		7,599		1999	5,184		5,321
1961	13,500		7,405		2000	5,022		5,216
1962	13,700		7,534		2001	5,042		5,229
1963	14,200		7,859		2002	4,726		5,024
1964	14,200		7,859		2003	4,725		5,023
1965	14,100		7,794		2004	4,999		5,201
1966	14,500		8,054		2005	4,961		5,177

Description of Estimated Occupational Fatalities

As can be seen from Table 7, the Estimated NIOSH Deaths calculates a lower number of occupational fatalities than NSC for all the years leading up to the 1992 change. In addition, the Estimated NIOSH Deaths varies from the reported NTOF deaths. According to the Estimated NIOSH deaths, the year with the greatest number of deaths was 1929 with 11,625. The year with the least number of deaths was 1991 with an estimate of 5,002. Since the change to the CFOI in 1992, the estimated occupational deaths from 1992 to 2005 have ranged from 5,002 to 5,421.

Using the estimated NIOSH fatalities, Figure 1 (data with LOWESS smoother) illustrates the decreasing trend of occupational fatalities from 1928-2005. In 1928, the estimated number of fatalities was almost 12,000. In 1972, the year when OSHA started inspections, the estimated number of fatalities was approximately 7,600 per year. In 2005, the number had declined to 5,177 occupational fatalities.
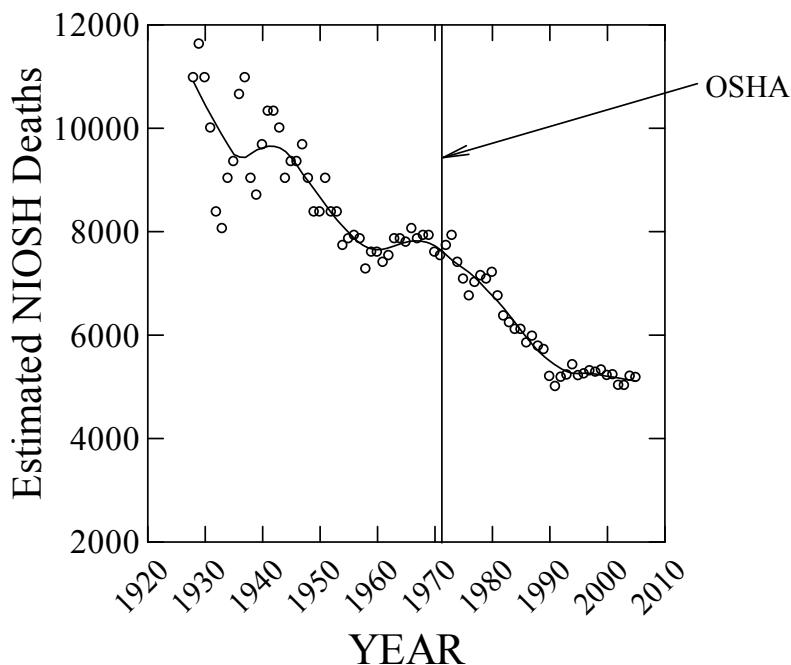

Figure 1. Estimated number of NIOSH deaths from 1928 to 2005.

As shown in Figure 1, there is an overall decrease in occupational fatalities. However, there are some periods where the decline plateaus. One of these plateaus occurred around 1950 and lasted until the passage of the OSHA Act around 1970. Closer examination of the post WWII years leading up to the inception of OSHA reveals no significant decrease in the number of occupational fatalities from 1954 to 1972.

This graph was further explored by looking at trends in different segments of the graph. From 1928 to 1952, there was a decline in occupational fatalities. The trend during this period was a reduction of approximately 69 fatalities per year. However, after 1952 the downward trend slowed and began to plateau. The trend in occupational fatalities from 1952 through 1971 slowed to approximately six less fatalities per year. In 1969, the year prior to the passage of the OSHA Act, the estimated number of occupational fatalities was slightly more than 7,900.

This stagnation in the decline of occupational fatalities that started in the 1950s was discussed in the congressional hearings during the Johnsons' Administration attempt to pass an occupational safety law. Secretary of Labor Wirtz "referred to the yearly statistics, 14,000 to 15,000 dead, over two million disabled, over 7 million hurt as a result of industrial accidents, emphasized that although some improvement had taken place prior to 1958, since then the accident rate had moved up steadily" (Mintz, 1985). However, the bill proposed in the Johnson administration did not pass.

The Nixon Administration was able to get the OSHA Act passed in 1970. One of the most persuasive reasons why the law was enacted was the continuing problems of occupational fatalities, injuries, and illnesses. Some of the most powerful statements came from Secretary of Labor Shultz in his report to congress about the need for an

occupational safety law. In his report, he emphasized the need for a law because conditions were deteriorating. He stated, "This grim current scene represents a worsening trend, for the fact is that the number of disabling injuries per million man hours worked is today 20% higher than in 1958. The knowledge that the industrial accident situation is deteriorating, rather than improving, underscores the need for action now" (Senate Report No. 1282, 91st Cong., 2d Sess. 2-4 (1970)).

After the passage of the OSHA Act, the reduction of annual fatalities increased to approximately 83 per year from 1972 to 2005. When examining the OSHA years closer, there are fluctuations in the intensity of the trend. There was a period of strong decline from 1972 to about 1990 and then another plateau after 1990. From 1972 to 1990, the trend for fatalities was a reduction of approximately 126 fatalities per year. This was a great improvement from the time immediately prior to the passage of the act. However, from 1990 to 2005, this trend has slowed to a reduction of approximately 3.5 fatalities per year.

There are multiple reasons why the decline in occupational fatalities slowed since 1990. One reason is better recording of fatalities. Even with the adoption of a census to count occupational fatalities and the creation of the NIOSH estimated deaths time-series in this research, there is a high likelihood that many occupational fatalities were not counted prior to 1992. Another cause of this trend could be due to progression of the agency and continuous improvement by employers. In essence, the agency has been very successful in preventing many of the fatalities and employers have improved safety in their workplaces. The fatalities that are occurring now may be more difficult to prevent

thus, causing the current plateau in occupational fatalities. Other reason may be due to agency, economic, or workforce factors that are explored in this research.

However, in my experience as an inspector in the field, I have seen numerous fatalities that should have been prevented if existing standards were followed. This indicates that the agency is not effectively enforcing its standards at all worksites. In addition, it also shows that employers could be doing more to protect employees from harm. However, every individual situation has its own set of circumstances. Although there were cases, where compliance would have most likely prevented the incident, there were also cases where the incidents were not foreseen and no standards were violated.

Even with the fluctuations in the number of occupational fatalities, as is depicted in Figure 1 and seen in Table 7, there has been an overall decline in the number of occupational fatalities from 1928 to 2005. However, as noted earlier, the decline has not been steady in those periods of stagnation of trends occurred periodically. The following analysis will explore how much of the overall downward trend and the periodic breaks in trend can be accounted for by factors related to the workforce, economic indicators such as GDP, or agency factors.

Another way of reviewing the trends in the number of occupational fatalities is to determine the deviation from trend. This shows the difference between what is expected and what has actually occurred with occupational fatalities. The deviation from trend of occupational fatalities also shows the fluctuation in the number of occupational fatalities. As seen in Figure 2, there have been strong declines in the fatalities, however in recent years the deviation from trend is showing more fatalities than expected.

The first decade of the agency from 1972 to 1982 showed an initial decline and then an increase in the trend of occupational fatalities. The establishment of the agency likely explains the initial decline. The deviation from trend started to climb from about 1975 to 1980. Starting in 1980 the trend began to decline and then held steady with a sharp decline at the end of the decade. However, starting about 1991, the trend of occupational fatalities is increasing.
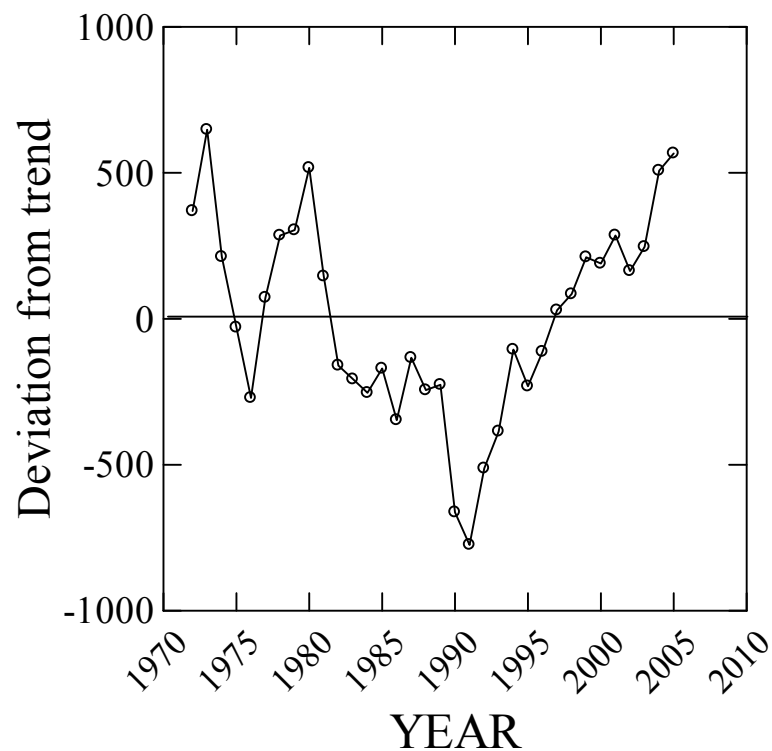
Figure 2. Deviation from trend for fatalities over time.

The break in the trend from about 1991 continuing to 2005 coincides with the stagnation seen in Figure 1. The two administrations in control of the agency the majority of this time were Presidents Clinton and G.W. Bush. During the Clinton Administration, there was an emphasis on government reinvention. Vice President Gore

chose the agency, to be one of the models of government reinvention. This process entailed training for all OSHA employees and emphasized employee involvement in the decision making of the work place. The goal was to have the agency leverage its resources and work more efficiently. However, this process required offices to be taken "off-line" for up to six months for the training. This in turn caused a decline in the number of inspections. Thus, there was less presence in the actual workplace.

The increase in the deviation from trend continued into the G.W. Bush Administration. Although inspections were at the same level or slightly more than the Clinton Administration, there were perceptions that the administration and agency were lax on enforcement efforts and implementing new standards. For instance, after well publicized combustible dust explosions like the one that occurred at a sugar refinery, the agency did not issue a standard. Instead, they opted to post guidelines and give resource information to employers on their website. However, regardless of the administration overseeing the agency, the trend since 1992 has occupational fatalities stagnating.

Description of Variables and Expected Signs of Models Predicting

Occupational Fatalities and Injuries

Agency factors, economic factors and workforce factors were chosen for this study because of their likely impact on occupational fatalities and injuries and illnesses. With that in mind, there were expected signs likely to occur with each of the variables. Agency Factors such as OSHA staff, inspections, budget and penalty are expected to have a negative sign or an inverse relationship with occupational fatalities and injuries.

As these factors increase, the number of fatalities and injuries should decrease. This would also support the deterrence effect of the agency. Increases in OSHA activity in the form of inspections, inspectors, budget and penalty will have the expected deterrence effect on injuries and fatalities.

The expected sign for cost of workplace injuries is positive. It is expected that as costs increase there would be more injuries, illnesses, and fatalities. In addition, GDP adjusted to 2001 dollars is also expected to have a positive sign. Increased GDP would increase the likelihood of exposure to an event that could cause an occupational injury or fatality. The expected signs for workforce factors such as income, population, female employed population, and unionization are expected to have a negative sign. As income increases, it is expected that the workplace is becoming safer and less incidents will occur. As the number of women in the workforce increases, the number of fatalities and injuries should decrease since women are less likely to be in high-risk jobs. In addition, unionization should have an effect in reducing the number of incidents and have a negative sign or inverse relationship with occupational fatalities and injuries. This is supported by study conducted by Baker and Scherer (1997) about construction sites that were unionized having fewer violations. Table 8 summarizes the expected sign and identifies the variables.

Table 8. *Variables and Expected Signs*

Variable Name	Description	Predicting Sign
OSHA Staff	Number of FTEs, this will include all inspection and administrative staff	Negative (-)
FEDOSHAINSP	The number of federal OSHA inspections that occurred in that fiscal year	Negative (-)
OSHABUDGET	The OSHA budget for that year adjusted to 2001dollars using the CPI inflation calculator	Negative (-)
PENALTIES	Penalty amount for OSHA violations adjusted to 2001 dollars. Years 1972-2000 were from IMIS database (Skisking, 2002). Years 2000-2007 were from AFL-CIO table using IMIS database.	Negative (-)
NSCCOSTS	The costs of occupational injuries according to BLS adjusted to 2001 dollars using the CPI inflation calculator	Positive (+)
GDP_2001	GDP adjusted to 2001 dollars using the CPI inflation calculator	Positive (+)
INCOME	Median household income obtained from CPS based on 2007 dollars.	Negative (-)
CIVILIAN_WORKFORCE	BLS civilian workforce employed in millions from the CPS employed	Negative (-)
POPULATION	Number of non-institutional population from the CPS	Negative (-)
FEMALE_POPULATION	Number in thousands of female non-institutional population	Negative (-)
FEMALE_EMPLOYED	Number in thousands of females in civilian labor force	Negative (-)
UNION	Number of union members	Negative (-)
PERCENTUNION	Percentage of union member	Negative (-)

Agency Factors

Agency factors used for this analysis include the number of OSHA inspectors,

number of federal OSHA inspections and the agency budget converted to 2001 dollars.

In addition, the penalty amount issued each year was also obtained and converted to 2001

dollars. The number of OSHA employees is important because they are the ones who conduct the inspections and enforce the regulations. More inspectors should increase compliance with the act and thus decrease occupational fatalities and injuries. The number of inspections should also indicate some type of relationship with occupational fatalities. If inspections increase, there should be a decrease in occupational fatalities. In addition, the agency's budget should also have an impact on the effectiveness of the agency. The budget is what provides the resources to the agency to conduct inspections, issue citations and provide outreach services. However, the agency's budget is also related to the number of employees and to the number of inspections. The extent of multicollinearity will have to be assessed when looking at these variables because staffing and inspections are related to budget.

Another variable that must also be addressed under the agency factors is the penalty amount associated with OSHA citations. As discussed in previous chapters, the agency uses deterrence theory in order to meet its mission to reduce fatalities, injuries, and illnesses. If this theory is to work, there has to be a threat of inspection. This threat should relate to budget, staffing, and inspections. The purpose of issuing penalties is to deter the acts that may result in occupational injuries, illnesses, or fatalities.

One of the first agency factors reviewed was the number of employees who work for the agency. The full time equivalent (FTE) number of employees has fluctuated over the history of the agency. In the startup years from 1972 to 1974, the average number of FTEs was approximately 1,700. This represents the lowest staffing levels for the agency but occurred when the agency was still being established. Then in 1980 the FTE number of employees increased to a high of 2,915 employees (Mean = 2306; S.D. = 265; Range =

1219). Then from 1980 until 1986, there was a steady decline in the number of FTEs, with the greatest loss of 556 FTE from 1980 to 1982 or about two standard deviations. In 1991, there was an increase in FTEs, which resulted in a staffing level of 2,466 FTEs. However, even with the recent increases, the agency never recovered the staff from the reduction in force (RIF) that occurred in the early 1980s. In addition, the variation in staffing is small, thus making detection of changes with staffing difficult. Figure 3 shows the number of FTEs over the life of the agency with a LOWESS smoother.
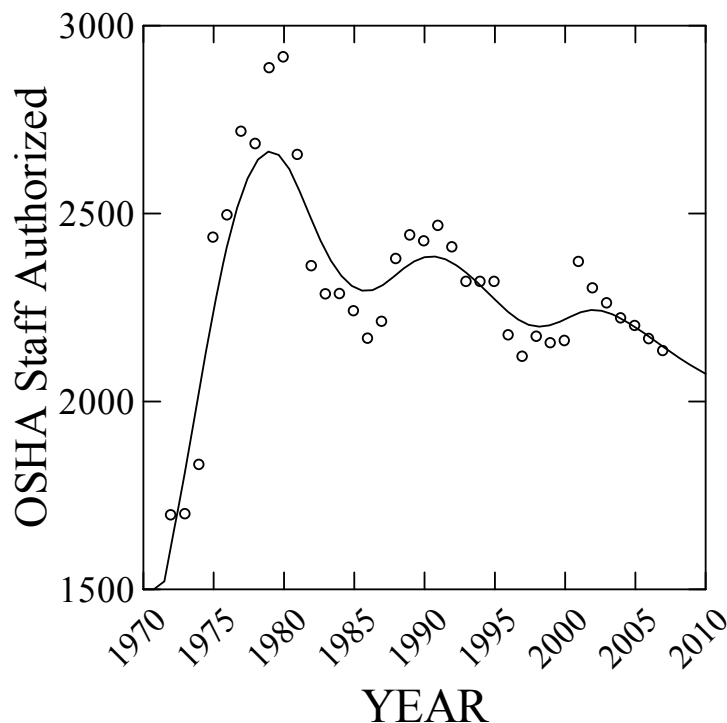
Figure 3. Number of full time equivalent employees for OSHA 1972-2007.

It is also important to understand how the number of inspectors affects the number of occupational fatalities. It is expected that there will be an inverse relationship with the number inspectors and occupational fatalities. That is as FTEs increase, the

number of fatalities will decrease because there is increased deterrence in the form of inspectors and inspections. In addition, more inspectors should result in more enforcement efforts making the employer more compliant with the regulations. However, as is seen in Figure 4, the relationship is not clear.
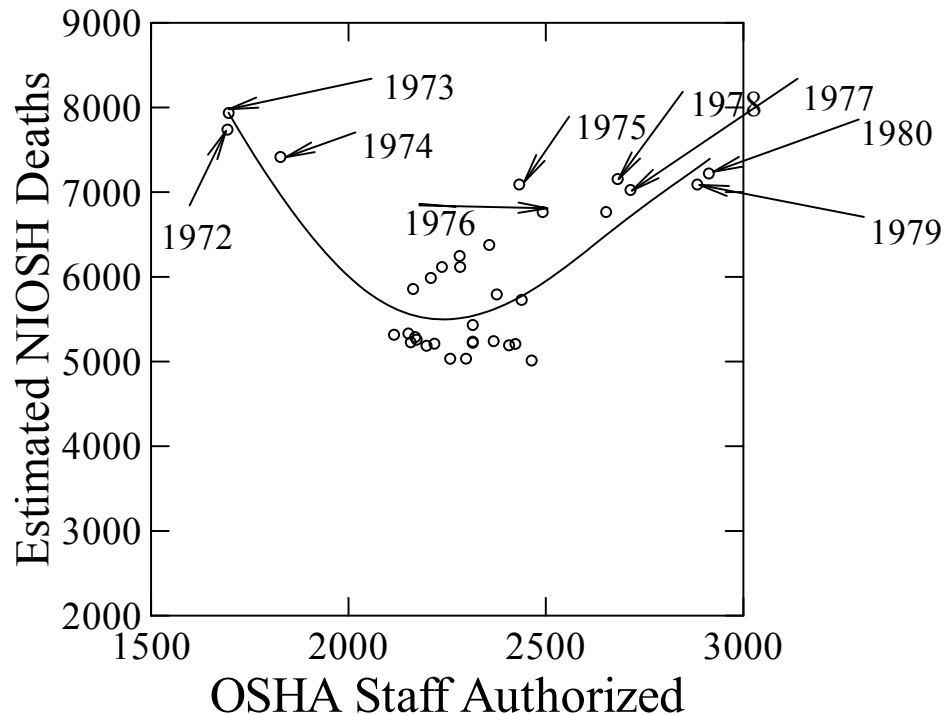

Figure 4. FTEs working for OSHA and the estimated number of workplace fatalities.

Figure 4 plots the estimated number of fatalities vs. the number of FTEs. This graph does not show an inverse relationship. Instead, Figure 4, results in a U-shaped line indicating that low numbers and high numbers of staff also have higher numbers of fatalities. However, when looking at the number of inspectors closer, the higher number of inspectors was found in the years between 1975 and 1980. This period had a higher number of fatalities and inspectors, but it also shows the greatest decline in the number of

fatalities (see *figure 2*). In addition, this was in the first years of the agency and many

organizations were still working to come into compliance with the agency regulations.

The number of federal OSHA inspections should also have a deterrence effect on

occupational fatalities and injuries. The number of federal OSHA inspections has

changed over the years. As indicated in Figure 5, inspections have also seen many

fluctuations over the years. The number of inspections was greatest in the beginning

years. The decline in later years could be due to the use of state plans, or due to

administrative policies that emphasize cooperative efforts as opposed to enforcement

efforts. In addition, many of the inspections in the start-up years lacked thoroughness,

which enabled more inspections in a shorter period than inspections that occurred in later

years.
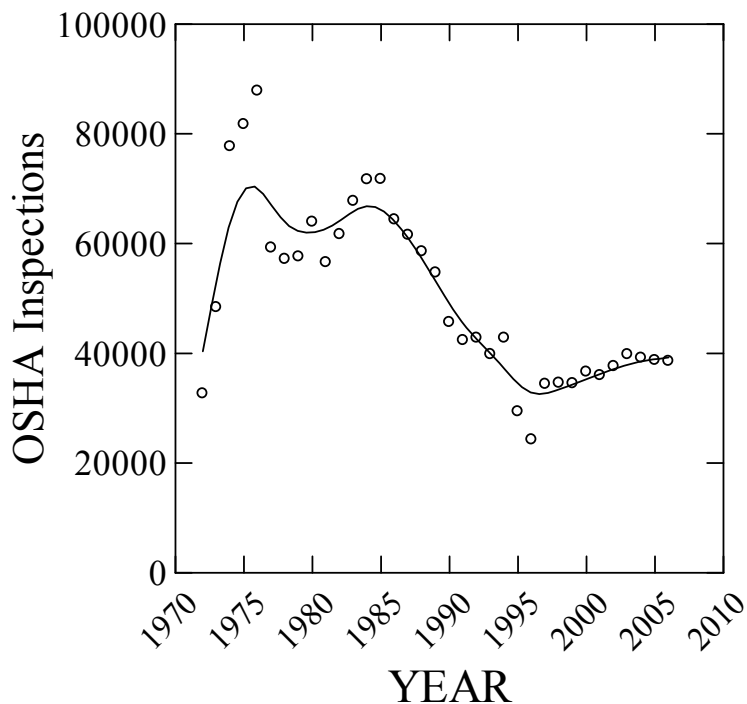
*Figure 5.* Number of federal OSHA inspections 1972-2007.

As can be seen from Figure 5, the number of inspections was the greatest in the years leading up to 1978. After 1978, a sharp decline in the number inspections occurred and continued until to 1985 when they increased to approximately 71,000 inspections. From that point, the federal inspections declined until 1996 with about 24,000 inspections and then there was an increase in 1997 to about 34,000 federal inspections. This number has slowly climbed since 1997 and has been staying consistent as of 2002 at approximately 39,000 inspections per year. Figure 6 depicts how the number of estimated fatalities relates to the number of inspections. According to the graph when the numbers of inspections range from 30,000 to 50,000 per year, the estimated fatalities were at their lowest. This range is also coincides with the most recent block of years between 1997 and 2005.
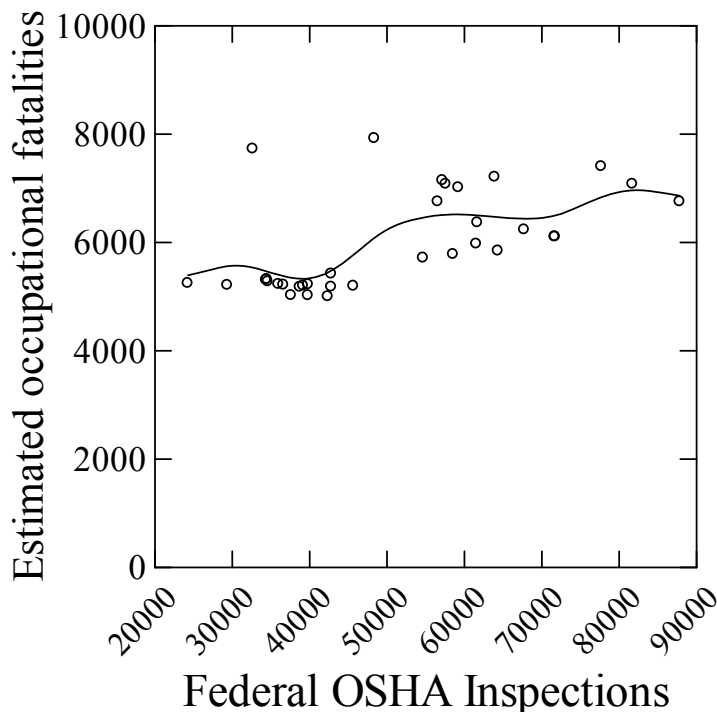
Figure 6. Number of federal OSHA inspections vs. the estimated number of occupational fatalities.

However, during the initial startup years were the most inspections and estimated fatalities. As stated before, these inspections lacked depth. It was also during these years that employers were working to come into compliance with the regulations. The agency and standards were relatively new to employers and the agency. The initial years after the inception of the agency were a learning period. This period is when employers became familiar with the standards and how to comply with the standards. Once standards were in place and employees were in compliance incidents began to decrease.
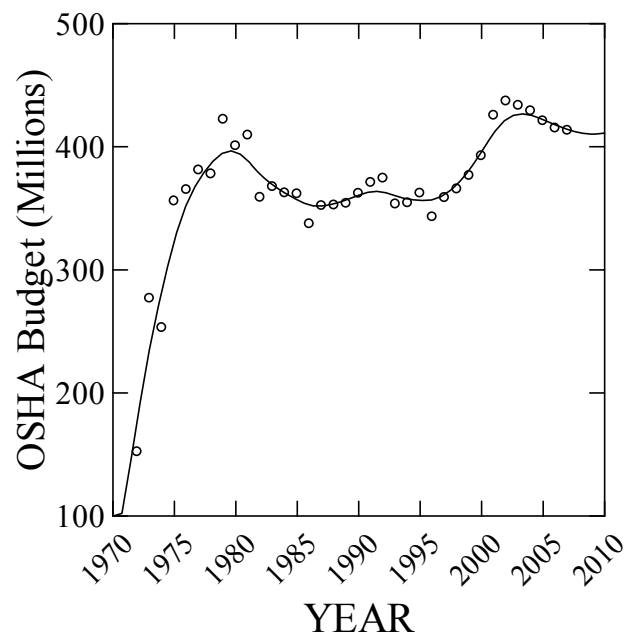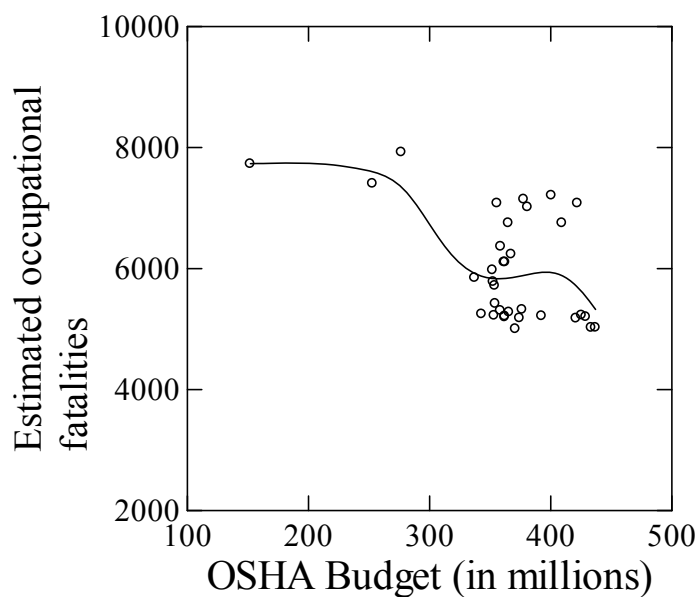

Figure 7. OSHA budget adjusted to 2001 dollars.

The agency budget was also analyzed to determine if it had an impact on the number of occupational fatalities. The budget was converted to 2001 dollars using the CPI calculator in order to make budgets from year to year comparable. The appropriations budgeted to OSHA in real dollars shows an overall increase. The largest increases in the budget occurred during the first eight years from 1972 to 1980. The

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budget decreased in 1982 and then stayed consistent until 2000 when there was a

noticeable increase. The budget peaked in 2003 and has since declined when using 2001

dollars. Figure 7 illustrates the fluctuations in the budget.

Since the budget provides the deterrence tools to the agency, it should have an

inverse relationship with the number of fatalities. Figure 8 depicts this relationship

between the OSHA budget adjusted to 2001 dollars and occupational fatalities. Although

the graph has many fluctuations, the trend is that as the budget increases, the number of

estimated fatalities declines.

Figure 8. Number of estimated workplace fatalities vs. OSHA budget adjusted to 2001

dollars (millions).

Penalty amounts were also considered when determining the effectiveness of the

agency. Penalty amounts are a tool the agency uses to deter violations of the OSHA Act

and thus may prevent occupational fatalities. However, the passage of the Budget

Reconciliation Act (OSHA Fact sheet 92-36) allowed maximum penalty amounts issued

by OSHA to increase seven fold. A serious violation of a standard now carries a

maximum penalty of $7,000 instead of $1,000. (See Appendix A for an explanation of

penalty structures and classifications.) As can be seen from Figure 9, the penalties have

fluctuated throughout the history of the agency from the 1970s through 2005.
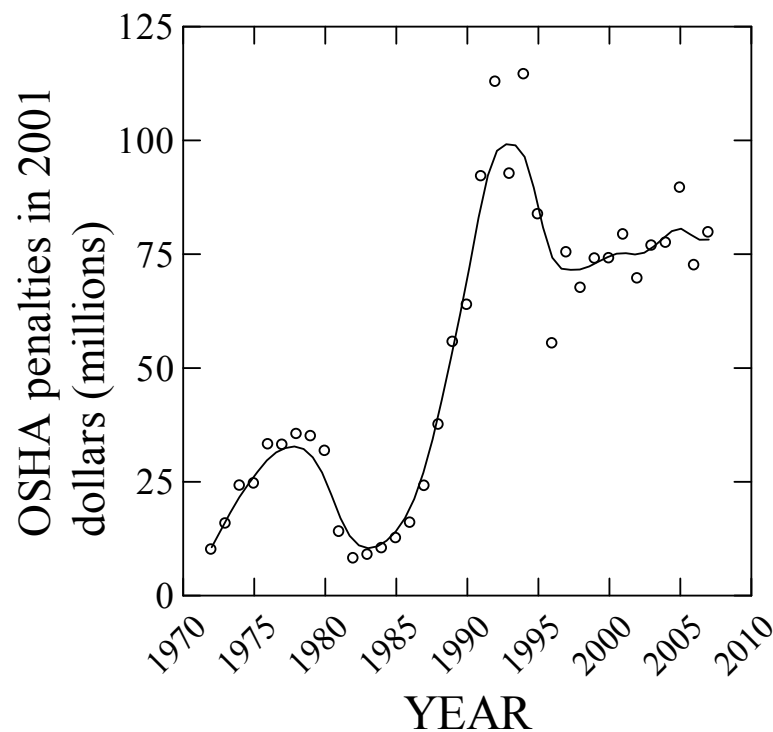
Figure 9. Total OSHA penalties in 2001 dollars.

Penalties are used to deter violations of the standard. Thus, increased penalties

will have a greater deterrence effect and thus decrease fatalities. Figure 10 depicts the

relationship of workplace fatalities and the total penalty amount issued (adjusted to 2001

dollars) over the life of the agency. As can be seen from figure 10, higher penalty

amounts do not seem to reduce occupational fatalities.
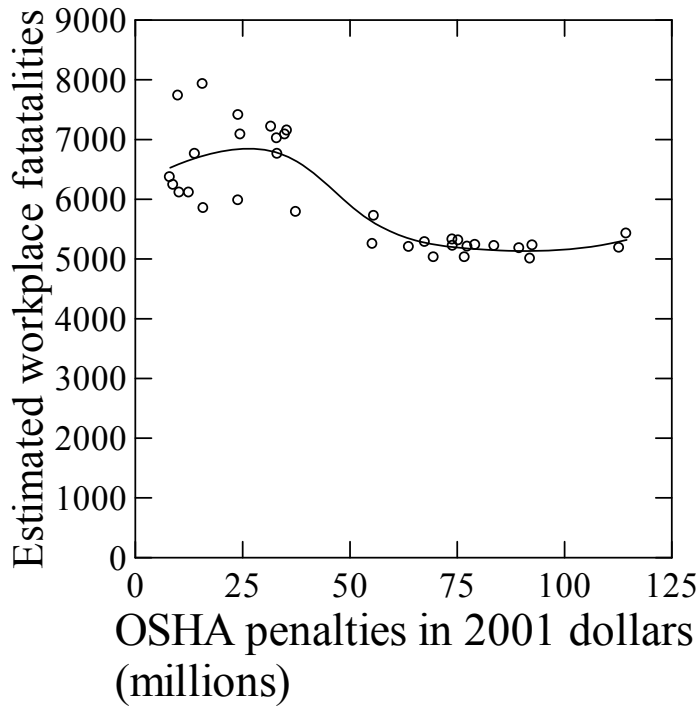
Figure 10. OSHA penalties adjusted to 2001 dollars and estimated number of workplace

fatalities.

Agency Factors and Occupational Fatalities

  Agency factors such as, budget, number of inspections, number of employees and

penalty amounts were used in an OLS regression to predict the number of fatalities. The

ability of agency factors to affect occupational fatalities is not entirely known. The

expected sign for agency factors is negative. This would show that, as agency factors

increase, there should be a decrease in the number of occupational fatalities. The

following model summarizes the OLS regression using agency factors and estimated

number of occupational fatalities.

Fatalities = 6876.927 + 1.164(OSHASTAFF) + 0.0065 (FEDOSHAINSP) -8.851(OSHABUDGET) - 13.626(PENMILLION)

(tail prob.)	(.000)	(.019)	(.422)	(.000)	(.002)
(tolerance)		.485	.462	.462	.442

R^2 = .720   n=34   SEE = 506.667   D-W= .672

R^2-adj.= .682

Where,

FATALITIES   =   Estimated occupational fatalities

OSHASTAFF   =   Number of FTEs

FEDOSHAINSP   = Number of federal OSHA inspections

OSHABUDGET   = Federal OSHA budget adjusted to 2001 dollars

PENMILLION   = OSHA penalties in millions adjusted to 2001 dollars

Although the expected sign for budget and penalties is negative, the regression is

not valid because of the Durbin-Watson statistic is in the rejection region. The output

produced a D-W of 0.672 indicating fatal autocorrelation. Thus, conclusions cannot be

drawn from this output. Other models were explored using the total number of

occupational fatalities did not find a statistically significant relationship free from

autoregression for agency factors and estimated occupational fatalities.

Economic Factors

Other factors that may explain workplace trends in occupational fatalities are

GDP and median household income. If GDP is increasing, workplace fatalities could

also be increasing because there is more opportunity for an event to occur. However,

GDP may also indicate that more funding is available to enhance the safety program of

the organization. The NIOSH estimated deaths time-series was used to compare

occupational fatalities to GDP. GDP was obtained from the United States Bureau of

Economic Analysis (BEA) and is listed in billions of dollars. In addition, GDP data were

converted to 2001 dollars using the CPI inflation calculator. Figure 11, shows the pattern

GDP increasing over time.
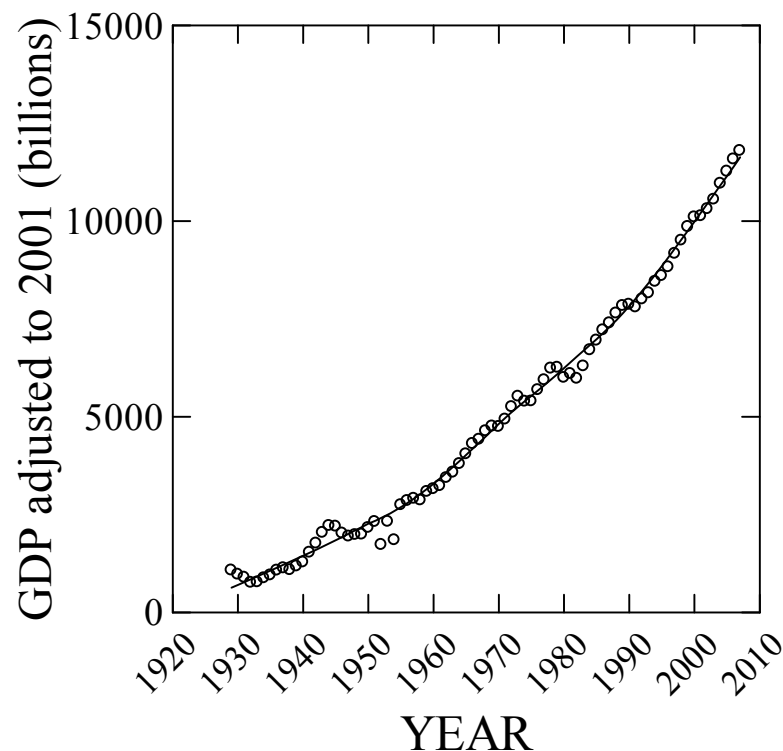
Figure 11. GDP in 2001 dollars from 1928-2005.

As can be seen in Figure 12 the overall trend is for fatalities to decrease as GDP

increases. These results do not support the theory that as GDP increases there are more

opportunities for adverse events leading to occupational fatalities, however it does

indicate another possible phenomenon. That is, as GDP increases, the organization may

have more time and money to emphasize the safety program and improve the safety

culture of the organization. In addition, technology changes may also improve workplace

safety by removing employees from hazards and thus reduce the number of fatalities.
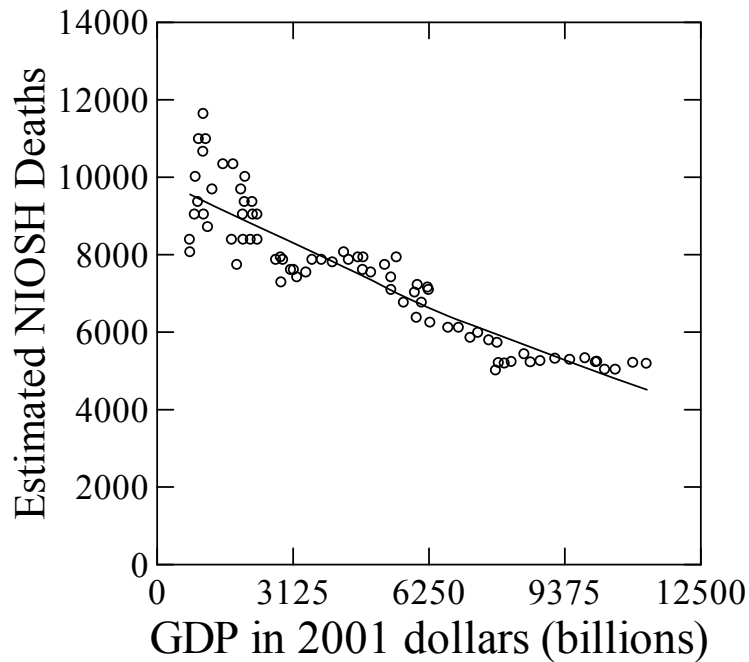
Figure 12. Estimated workplace deaths compared to GDP in 2001 dollars.

Another economic factor is how much money employees are making in the

workplace. This factor was chosen because as income increases, jobs may become safer

and an employees' expectation of safety may increase. Data were obtained from the

current population survey on the median household income. This income from the

current population survey was listed in 2007 dollars. In Figure 13, as income increases

the number of fatalities decrease. However, as income has approached $50,000, the
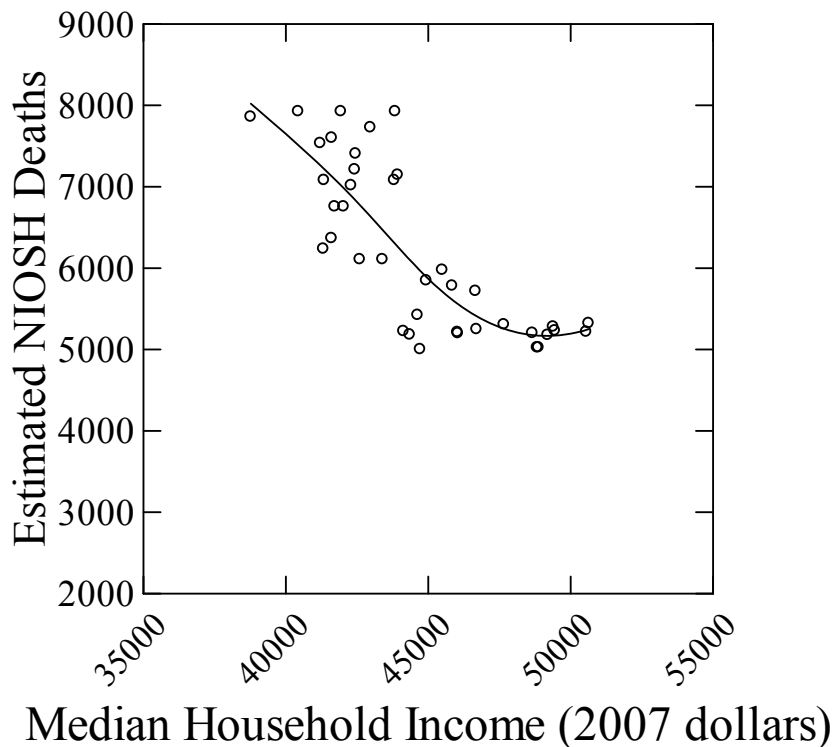
number of occupational fatalities has leveled.

Figure 13. Estimated workplace fatalities vs. median household income in 2007 dollars.

Running the OLS regression using the estimated number of fatalities as the

dependent variable and GDP converted to 2001 dollars as the independent variables, does

not result in a statistically significant relationship free from autoregression. Other models

were explored and did not show statistically significant relationships free from

autoregression.

Another economic factor is total cost to the employers associated with workplace

fatalities, and injuries and illnesses. NSC publishes cost data related to occupational

events such as injuries, illnesses and fatalities in their annual publication *Injury Facts*.

The costs given by NSC include direct costs such as lost wages and workers

compensation insurance and hidden costs such as lost productivity and administrative

costs associated with the injury. Since the employer pays these costs, they have an

incentive to initiate pro-active safety policies in the work environment to reduce injuries, illnesses and fatalities thereby reducing the costs associated with these events.

Data on the cost of workplace incidents were collected from NSC and converted into 2001 dollars. As can be seen from Figure 14, as the costs increase, the number of fatalities decrease. The increase in the costs may be due to increases in the costs of care and not increased incidents of injuries or fatalities. In addition, medical care may have also improved to where more employees who are involved in a serious incident survive the incident. This may also account for the increase in cost, since it is likely that this type of care would be more expensive.
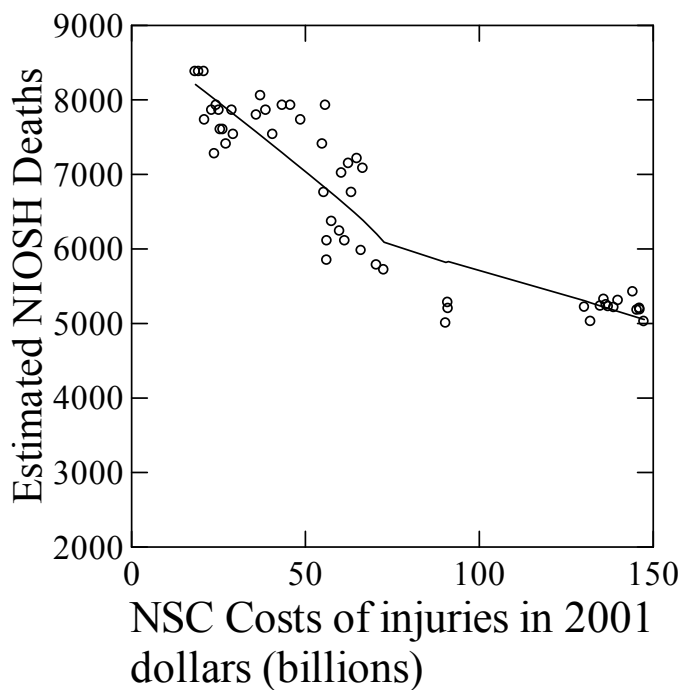
Figure 14. Estimated number of workplace fatalities and NSC costs adjusted to 2001 dollars (billions).

The penalties associated with OSHA violations are another employer cost the agency uses as a deterrence tool. If a violation of a standard is found during an inspection, a citation with a penalty may be issued. The citations are issued to ensure abatement of the alleged hazard. If the hazard is abated or removed, there should be reduced likelihood of an injury or fatality. This would indicate that increased penalty amounts would give an employee an incentive to comply with the regulations.

Using estimates from NSC on costs of injuries and penalty amounts issued, results in the following output. However, this model did not produce a statistically significant relationship free from autoregression. Other models were explored and resulted in similar findings.

Fatalities $= 7556.205987 - 13.2087706(NSC\_Costs) - 0.0068772(penalties)$
(tail prob.)   (.000)   (.024)   (.302)
(tolerance)   .211   .211
$R^2 = .638$ n=33   SEE $= 553.357$ D-W$= .506$
R^2-adj.$= .614$
Where,

Fatalities   =   Estimated occupational fatalities using costs and penalties

NSC_Costs   =   Cost of occupational injuries and illnesses as estimated by NSC

Penalties   =   OSHA penalties adjusted to 2001 dollars

Workforce Factors

Another set of variables that were also collected are related to workforce factors. The Current Population Survey (CPS) was a source for population and employed population in the United States. Workforce factors such as working population could affect the number of workplace fatalities. If there are more employees in the workforce,

there are more opportunities for a fatality. In addition, if there are more employees and

fatalities decrease, the workplace may be safer.

The BLS CPS provides data on employment and income. One of the BLS CPS

tables (employment status of the civilian non-institutional population 1942 to date) have

data from 1947 to 2007 on the total civilian non-institutional population age 16 and over

and the total number employed in the civilian labor force (BLS CPS, 2008). Another

table from the current population survey had employment status of the civilian non-

institutional population 16 years and over by gender from 1973 to date. This broke down

non-institutional population and employment status by gender. However, a problem with

this table is that it covers 1973-2007. Data regarding employment status of women for

prior years was obtained by utilizing the Census Bureaus' Statistical Abstracts of the

United States. This data were obtained back to 1960. The years prior to this had

inconsistent data listed in the annual tables and were not used.
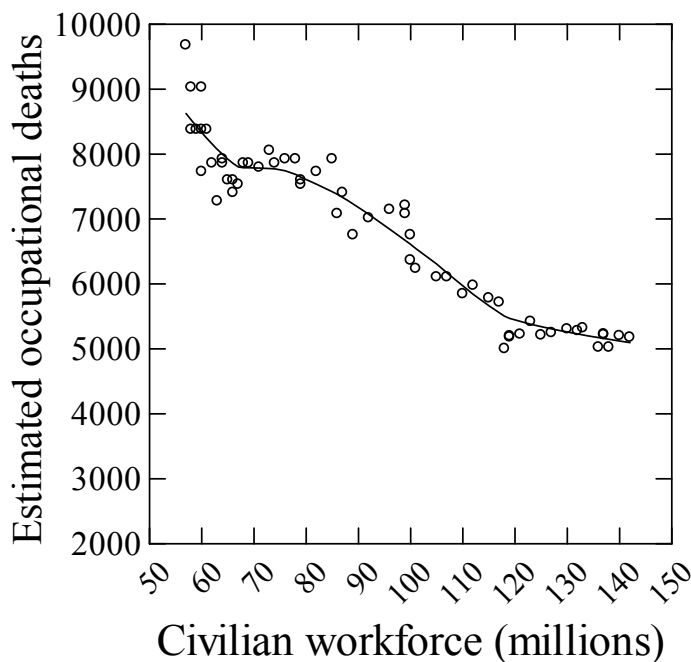
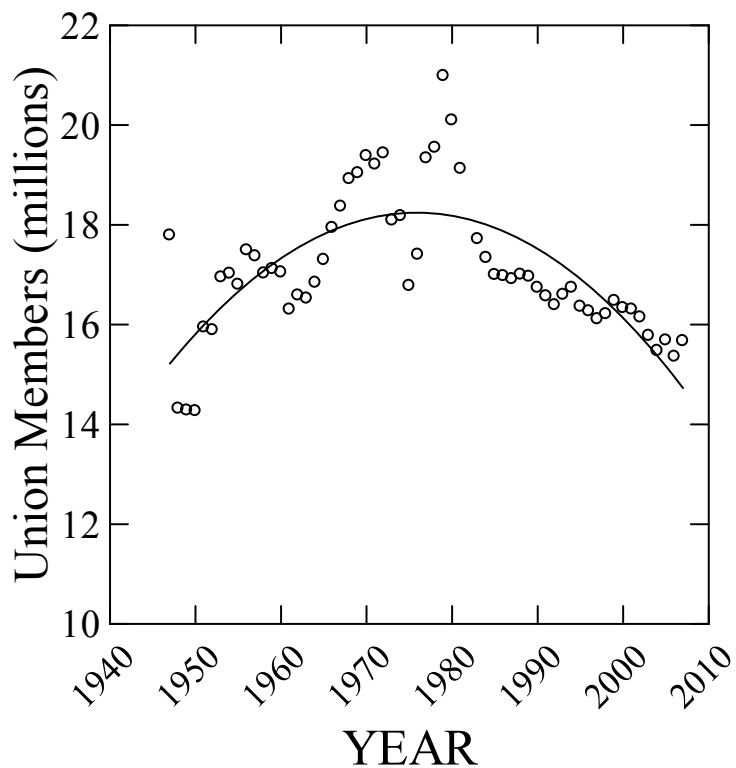*Figure 15*. Workplace fatalities vs. population.

The graphs for total civilian workforce and female workforce trend in a similar manner with respect to the estimated number of occupational fatalities. Figure 15, shows how workplace fatalities have declined as working population has increased. Figure 16, shows how workplace fatalities have declined as employed female population has increased. Both figures show a strong downward trend with flattening at the most recent workforce levels. The downward trend in estimated NIOSH fatalities plateaued when the employed number of the civilian labor force reached approximately 120 million and when females employed reached approximately 55 million.
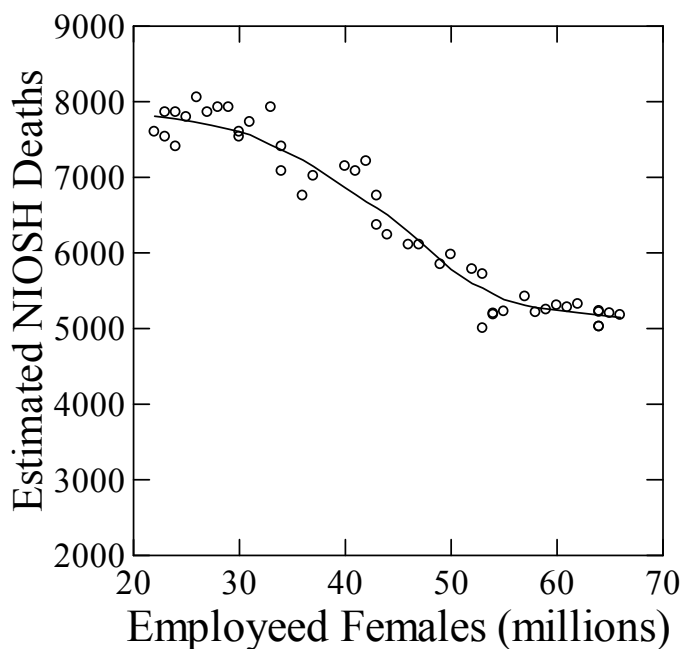
Figure 16. Workplace fatalities vs. female workforce.

Another workplace factor that was used was the percentage of unionization. Unions have a history of supporting occupational safety. However, there has been a secular decline of union members as a percent of the workforce. A report developed by

Mayer (2004) for the Congressional Research Service provided information about the total number of union members and the percentage of union membership in the working population. As can be seen from Figure 17, the number of union members steadily increased from the 1950s to late in the 1970s. Since the 1970s, the total number of unionized workers has declined in the United States. As seen from Figure 18, there has been a steady decline in union membership as a percent of the labor force.

Figure 17. Number of union members in the United States from 1940-2003.
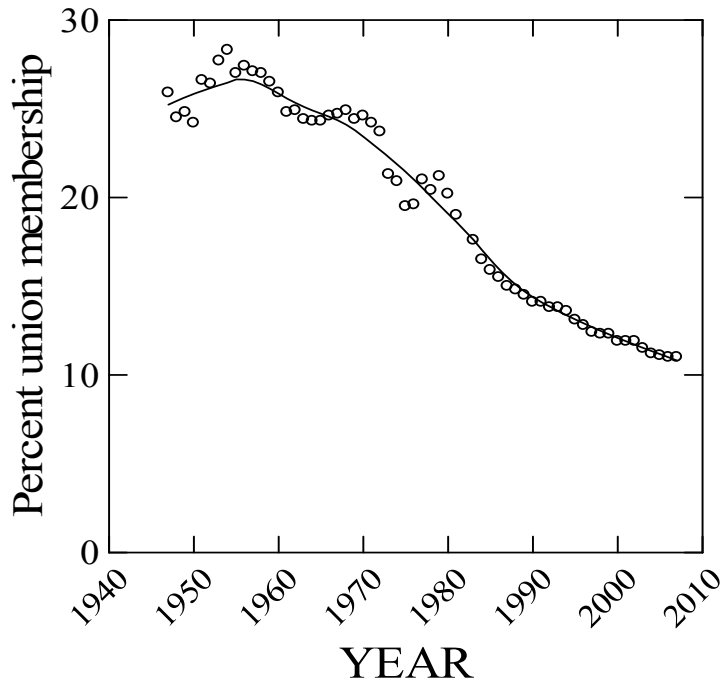
Figure 18. Percentage of union members 1945-2003 vs. working population.

One of the research questions relates to unionization and the impact of workplace fatalities. When using the total number of union members or the percent of union membership in an OLS regression resulted in models that did not find a statistically significant relationship free from autoregression. Another OLS regression was run to take into account the implementation of OSHA on fatalities and union membership. A dummy variable was used to separate the OSHA years and non-OSHA years. This resulted in a model that did not find a statistically significant relationship free from autoregression. Other alternative models were explored using population variations and had similar findings.

Using Occupational Fatalities

The models explored using the estimated number of occupational fatalities in this section did not find statistically significant relationships free from autoregression with agency factors, economic factors, or workforce factors. Using occupational fatalities to measure the effectiveness of OSHA may not be the best method. This is partly because occupational fatalities are rare events (Drudi, 1997). This means that there may not be enough fatalities to detect the impact of OSHA or other variables on the number of fatalities. This issue caused the models using the overall estimated number of fatalities to be highly autoregressive and invalid. This does not mean that occupational fatalities are not affected by agency factors, economic factors or workforce factors. It just indicates that influences are difficult to detect. However as stated by former Secretary of Labor Willard Wirtz in reference to occupational fatalities,

> But to relay on aggregate statistics in this area demeans our humanity. If this kind of human tragedy touched our families it would make us committed crusaders. It cheapens us as individuals to let ourselves, especially if we carry public responsibility find refuge in our personal good fortune. (Hearings on S. 2864 Before the Subcomm. On Labor of the Senate Comm on Labor and Public Welfare, 90th Cong., 2d Sess. 69, 69, 71-73 (1968))

Another method to determine the impact of agency, economic, and workforce factors on occupational fatalities is to determine the year-to-year difference in the number of fatalities and conduct an OLS regression using the different variables. This was done using a combination of agency, economic, and workforce variables to determine their

impact on the year-to-year difference in occupational fatalities. Only the OLS regression model using the year-to-year difference and federal OSHA inspections, showed a statistically significant inverse relationship free from autoregression. This model indicates that OSHA inspections have the desired effect on the reducing the number of occupational fatalities from year-to-year and that 10,000 additional inspections will decrease the number of occupational fatalities by approximately 54 per year.

$YEARDIFF = 197.7564643 - 0.0054394(FEDOSHAINSP)$

(tail prob.)   (.095)   (.020)

(tolerance)   (1.00)

$R^2 = .156$ Adjusted $R^2 = .129$ $n = 34$ $SEE = 201.252$ $D\text{-}W = 1.968$

Where,

YEARDIFF   =   The year to year difference in the number of estimated

                          occupational fatalities

FEDOSHAINSP   =   The number of federal OSHA inspections that occurred in

                          that fiscal year

Increasing the number of inspections will also have an effect on the other agency variables such as penalties, staff, and budget. Increasing inspections will also increase the need for staff to conduct the inspections. In addition, the agency budget will also need to be increased to conduct the additional inspections and to compensate the staff. Additional penalties will likely be issued, thus increasing the annual penalty amount assessed by the agency. Increasing the number of annual inspections has the potential to

reverse the current stagnation in the number of occupational fatalities. However, these inspections must be in the areas were the fatalities are occurring and must be quality inspections. Budget resource must also be allocated to the agency to increase the inspections.

In addition, another method to determine the effectiveness of OSHA is to review its impact on occupational injuries and illnesses. Occupational injuries and illnesses occur at a greater frequency and may give a better indication of the effectiveness of OSHA. Using the same variables for agency, economic, and workforce factors, the impact of OSHA was evaluated using occupational injury and illness statistics.

<center>OSHA's Impact on Workplace Injuries</center>

In addition to reducing fatalities, the OSHA Act was enacted to reduce workplace injuries and illnesses. The next section explores how occupational injuries and illnesses have been impacted by the passage of the OSHA Act. As stated before, occupational fatalities are rare events (Drudi, 1997). However, occupational injuries and illnesses occur more often and may give a better indication of the effectiveness of the agency. There are more incidents of injuries and illnesses than there are of occupational fatalities.

The passage of the OSHA Act required BLS to collect information on fatalities and injuries for all industries. Prior to the passage of the OSHA Act, BLS did collect data on certain industries such as steel mills, manufacturing, and construction from many states. However, this information was not comprehensive in that not all states participated and data was not available for all industries. BLS collection of injury and illness data has always been survey based. There have been modifications of the survey

to provide detailed information, however for the most part the survey has captured the same information. With the passage of the act, the survey was administered to all states and data were collected from all industries (Drudi, 1997).

Developing a Time-series on Occupational Injuries and Illnesses

As with the fatality data, there are issues with injury and illness data and changes in BLS collection pre & post OSHA Act. BLS tracked injuries and illnesses for all sectors from 1957 until present. However, prior to 1972, data was limited to only a few states. In 1972, because of the passage of the OSHA Act, BLS collected data from all states on all industries. The BLS system from 1972 is a good indicator of the number of occupational injuries and illnesses and is widely accepted, even though it uses a survey method (Drudi, 1997).

There were changes in the method of administering the survey. The most profound change occurred in 1992 when the survey became mandatory. Each year BLS, sends surveys to employers asking them to complete information regarding occupational injuries and illnesses. Prior to 1992, employers who did not comply with the request had no consequence. After 1992, the "non-responders" could receive an OSHA inspection if they did not respond to the annual survey. According to Drudi, making the survey mandatory solved the non-sampling bias created by non-responders or employers who were trying to "hide" injuries (Drudi, 1997). A concern now was employers who refused to report before the survey became mandatory, could skew the results. Once the BLS survey became mandatory, there was an increase of approximately 450,000 injuries and illnesses from 1991 to 1992. This may have been due to the mandatory reporting

requirement or there was an actual spike in injuries and illnesses. However, the

difference from 1990 to 1992 was only about 50,000 injuries and illnesses, which is

consistent with year-to-year difference after 1992.

In addition, NSC also collected data and created estimates of workplace injuries

and illnesses. Using NSC and BLS data to establish a definitive number of injuries and

illnesses was attempted in much the same way as determining the NIOSH fatalities. In

order to estimate the number of occupational injuries and illnesses that occurred prior to

the passage of the OSHA Act and the comprehensive survey by BLS, the following

model was used.

BLS estimated injuries & illnesses $=$ $\alpha + \beta(\text{INJURIES\_NSC}) + (\text{INJURY\_DUM})$

Where: INJURIES_NSC $=$ the number of injuries & illnesses reported

by NSC

INJURY_DUM $=$ 0= years prior to BLS change 1991; 1=years

after BLS change 1992

However, this equation and the output are not usable. The R^2 and adjusted R^2 are

0.06 and 0.00, indicating that there is no explanation of the variance. In addition, this

model did not find a statistically significant relationship free from autoregression. Injury

and illness statistics were not able to be reconciled in the same manner as occupational

fatalities. Since the equation was not a good predictor and the BLS data did not vary

much from the 1992 change, the data reported by BLS during OSHA years were used in

the following analysis. As seen in Figure 19, there has been a decline in the number of

occupational injuries and illnesses reported by BLS since the start of OSHA in 1972. In 1972, there were approximately 5.6 million occupational injuries and illnesses reported by BLS. In 2006, this number dropped to 4.1 million occupational injuries and illnesses.

However, the years between 1972 and 2006 showed much fluctuation in the number of injuries and illnesses reported. Occupational injuries and illnesses stayed steady from 1972 to about 1984 when they started to increase. The peak number of injuries and illnesses reported occurred in 1992 when the survey became mandatory. Since 1992, occupational injuries and illnesses have steadily declined.
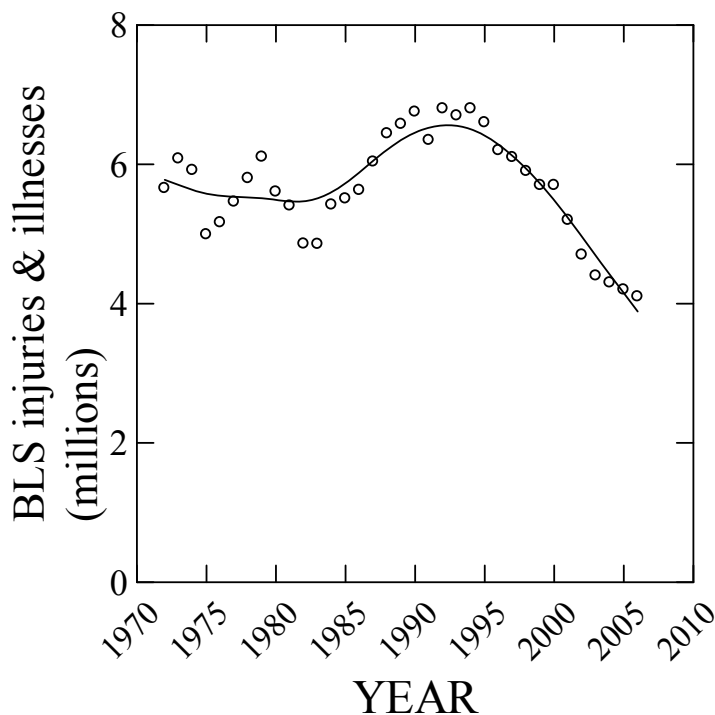
Figure 19. Total injuries and illness reported by BLS 1972-2005.

In addition, to reporting the total number of injuries and illnesses, BLS also publishes injury and illness data in a rate format. The rate format takes into account

employee hours worked. Prior to the passage of the OSHA Act, BLS reported injuries

and illnesses in a rate based on one million hours. After the passage of the act, the rate

data were published per 100 employees working 200,000 hours per year using the
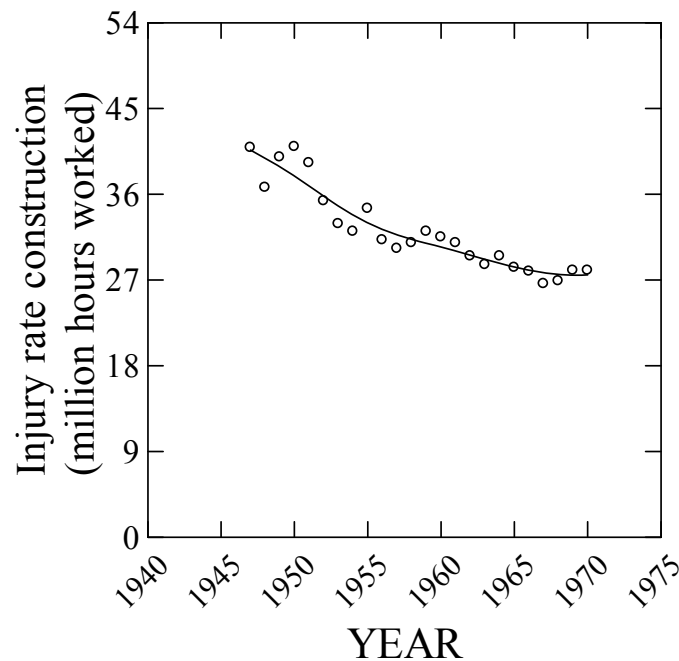
following formula:

Injury Rate = <u>Total number of injuries & illnesses</u> x 200,000
                              Total number of hours worked

The injury and illness rate calculation relates the number of injuries and illnesses

based on hours worked. This calculation is standardized by multiplying the equation by

200,000, which equates to 100 employees working 2,000 hours per year or 40 hours per

week for 50 weeks each year. This allows the comparison of rates from different

organizations and industry sectors. In addition, this also accounts for changes in hours

worked and overtime.

BLS also collected injury and illness data in a rate format prior to the

establishment of OSHA using million hours worked. However, when comparing the data

pre and post OSHA, there is a great disparity in the rates reported. This disparity is most

likely due to underreporting since only a few states participated in the survey (Drudi,

1997). For instance, using the data reported by BLS for construction in 1970, there were

28 injuries and illnesses per one million hours worked. In 1972, BLS reported an injury

and illness rate for construction of 19, based on 100 employees working 200,000 hours.

Converting the 1970 rate to the new reporting method would result in a rate of 5.6 (28 ÷

1,000,000 x 200,000 = 5.6). However, it is unlikely that the rate in construction went

from 5.6 to 19 from 1970 to 1972. The more likely cause of this large increase is lack of

participation of states and poor administration of the survey used prior to 1972.

The trend for injuries and illnesses for construction leading to the passage of the

OSHA was a minimal decline. The injuries and illnesses for construction were stagnated

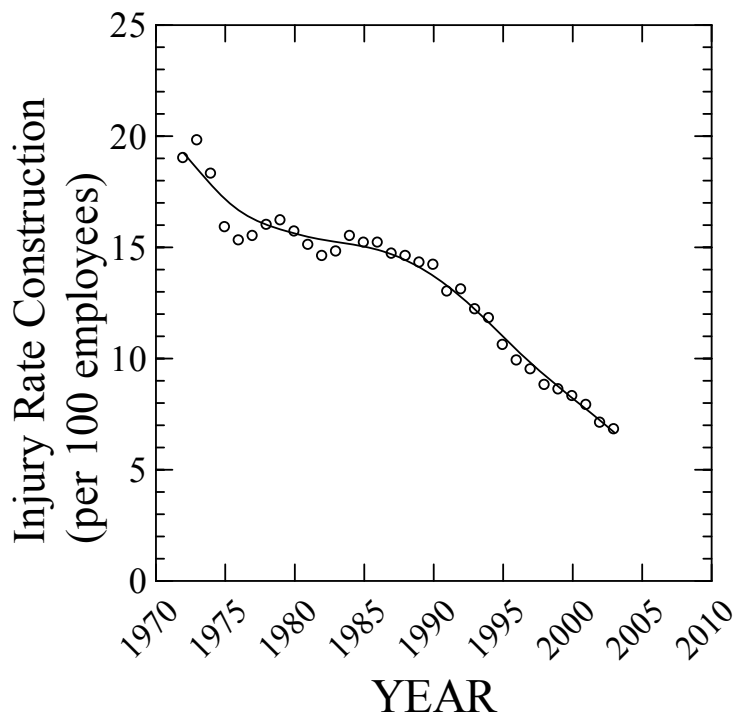as seen in Figure 20.

Figure 20. BLS rate of injuries and illnesses per million hours worked in construction

1945-1970.

The injury and illness rate for construction reported after the passage of the

OSHA Act is standardized by using the following formula:

Injury Rate Construction   =   Number of injuries & illnesses   x 200,000
                                          Employee hours worked

The trend for injuries and illnesses after the passage of the OSHA act was a steady

decline. Figure 21 shows a steady decline in the number of occupational injuries and

illnesses for construction from 1972-2005 using injury and illness rates.

Figure 21. BLS injury and illness rate for construction from 1972-2005.

The injury and illness rates pre and post OSHA for manufacturing trend very

differently than the rates for construction. Using the rate for manufacturing pre and post

OSHA Act results in the following figures. Figure 22 shows the trend of occupational

injuries and illnesses prior to the passage of the OSHA Act for manufacturing. Injuries

and illness were declining from about 1945 to about 1955. After 1955 and lasting until

the passage of the OSHA Act, injuries and illnesses began to increase in manufacturing

sectors.
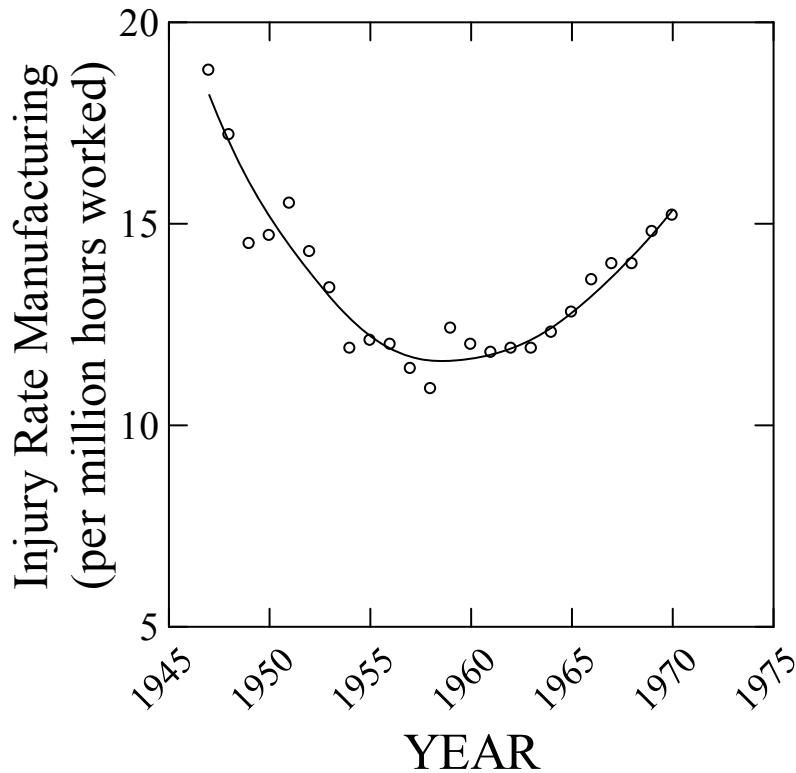
Figure 22. BLS rate of injuries and illness per one million hours worked in Manufacturing 1945-1970.

After the passage of the OSHA Act, the manufacturing injuries and illnesses initially began to decline as seen from Figure 23. However, between 1982 and 1992 there was an increase in the number of injuries and illnesses for manufacturing. Then after 1992, the trend began to decline. From that point, the injury and illness rates for manufacturing have continued to decline.
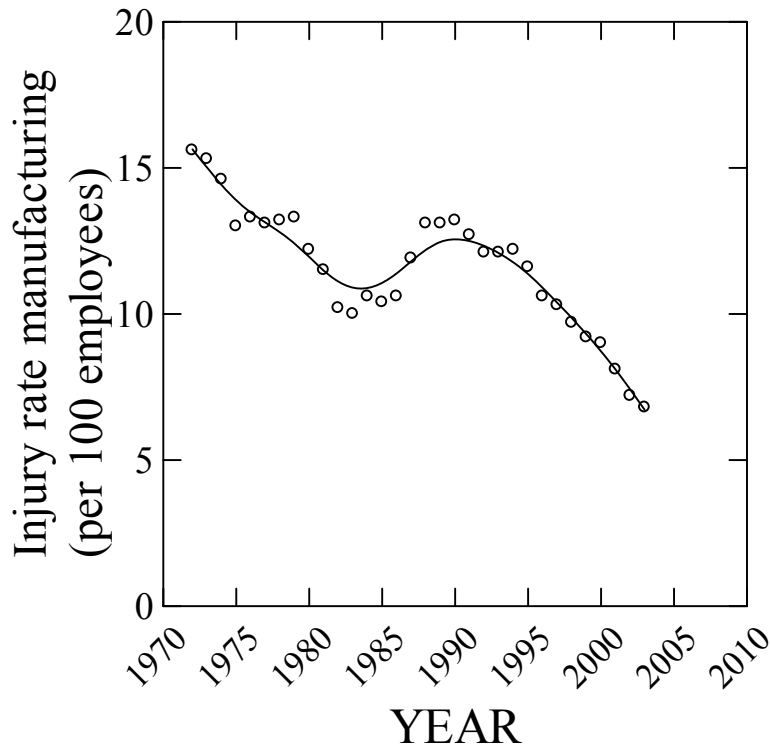
Figure 23. BLS injury and illness rate manufacturing per 200,000 hours worked 1972-2005.

In addition to separate rates for construction and manufacturing based on 100 employees working 2,000 hours per year, BLS also reports an overall injury and illness rate for all industries. Although less pronounced, the injury and illness rate for all sectors has some similar features as the injury and illness rate for manufacturing. This may be due to the number of employees who are working in the manufacturing sector. Figure 24 shows the overall injury and illness rate for all industries as reported by BLS. Since the inception of OSHA, there has been an overall decline in the total injury and illness rate. However, there was a plateau in the rates from approximately 1980 to 1995. After 1995, the rates began to decline again. When comparing the overall injury and illness rate to the rate for manufacturing in Figure 23, there are similar patterns.
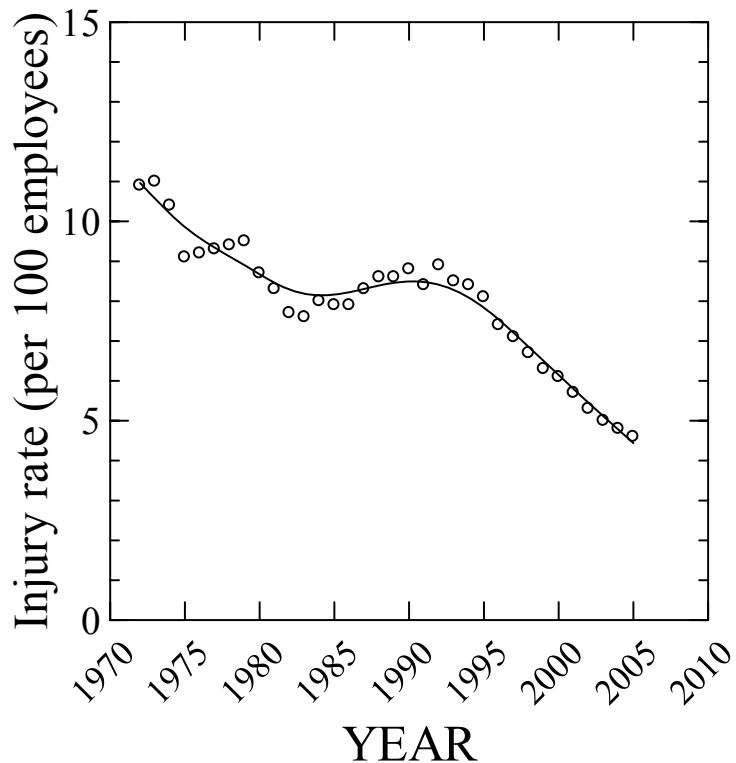
Figure 24. Overall BLS injury and illness rate 1972-2005.

Injury and Illness Analysis

OSHA's impact on injuries and illnesses were analyzed in the same way as occupational fatalities. These factors, agency, economic, and workforce factors, were used with the overall number of injuries and illnesses and the injury and illness rate to determine the effectiveness of the agency. An advantage of using occupational injuries and illnesses is that they occur more often than fatalities, allowing changes to be detected more readily.

Using Agency Factors to Determine the Impact on Injury and Illness

Among the factors used to determine the agency's impact on injuries and illnesses were OSHA budget, number of inspectors and number of inspections. It was expected

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that the agency factors would have an inverse relationship with the overall number of injuries reported by BLS. Using OLS regression to review the agency factors related to the number of occupational injuries and illnesses as reported by BLS resulted in the following output.

INJURIES_BLS = 6.4345812 +.0019586(OSHASTAFF)-.0000190(FEDOSHAINSP) - .0118602(OSHABUDGET)

(tail prob.)   (.000)   (.001)   (.015)   (.000)

(tolerance)   .505   .802   .541

R^2 = .399   Adj. R^2 = .342   n=35   SEE = .624   D-W= .768

Where,

INJURIES_BLS   =   BLS number of occupational injuries in millions

OSHASTAFF   =   Number of FTEs, this will include all inspection and

                                        administrative staff

FEDOSHINSP   =   The number of federal OSHA inspections that occurred in

                                        that fiscal year

OSHABUDGET   =   The OSHA budget for that year adjusted to 2001dollars

                                        using the CPI inflation calculator

        The results from this output found statistically significant *beta* coefficients however there was serious autoregression. In this output, case 45 has leverage and skewed the results. This case happens to be the first year that OSHA was conducting inspections and was part of the startup year 1972. In 1972, few inspections were conducted and staffing was not complete. The startup year 1972 was removed from the OLS regression, and the regression was repeated. Eliminating 1972 from the regression, results in the following output.

INJURIES_BLS = 9.9601126+.0025353(OSHASTAFF)-.0000337(FEDOSHAINSP)-.0227963(OSHABUDGET)

(tail prob.)	(.000)	(.000)	(.000)	(.000)
(tolerance)		.568	.381	.531

$R^2 = .735$ Adj. $R^2 = .710$ n=34   SEE = .421   D-W= 1.32

Where,

INJURIES_BLS   =   BLS number of occupational injuries in millions

OSHASTAFF   =   Number of FTEs, this will include all inspection and

administrative staff

FEDOSHINSP   =   The number of federal OSHA inspections that occurred in

that fiscal year

OSHABUDGET   =   The OSHA budget for that year adjusted to 2001dollars

using the CPI inflation calculator

The variables in this model show a statistically significant relationship with the

reported number of occupational injuries and illnesses. In addition, this model places the

Durbin-Watson in the inconclusive region and indicates that there is no fatal

autoregression. This regression indicates that as OSHA budget and number of

inspections increases, the number of injuries and illnesses decreases. However, the

number of OSHA inspectors does not vary inversely with the number of occupational

injuries and illnesses.

Although the number of inspectors does not have an inverse relationship with the

number of injuries and illnesses, does not necessarily mean that inspectors are not

reducing injuries and illnesses. One of the advantages of having a better-staffed

inspection agency like OSHA is that a larger percentage of total injuries are likely to be

reported. More inspectors in the field will likely result in the detection of more injuries and illnesses.

BLS also reported injuries and illnesses in a rate format. The rate format used for reporting injuries and illnesses since the passage of the OSHA Act is based on 100 employees working 200,000 hours per year. An advantage of using the rate is that it takes into account the number of hours worked which accounts for overtime and changes in employment. Thus, it cannot be argued that the significance of the agency variables are really due to changes in overtime or employment.

An OLS regression equation was specified using the BLS injury and illness rate and agency factors such as staff, inspections, and budget. In this model, as with the model using the overall number of injuries and illnesses, 1972 had large leverage. Eliminating 1972 form this OLS regression resulted in the following model.

BLS_injuryrate $= 12.6757110 + .0045282$(OSHASTAFF) $+ .0000051$(FEDOSHAINSP) $- .0421652$(OSHABUDGET)
(tail prob.)　　　(.000)　　　　　　(.000)　　　　　　(.528)　　　　　　(.000)
(tolerance)　　　　　　　　　.541　　　　　　.692　　　　　　.510
$R^2 = .864$　　　　Adj. $R^2 = .850$　　　n=33　SEE = .608　D-W= 1.79
Where,

BLS_INJURYRATE =　　BLS injury rate

OSHASTAFF　　=　　Number of FTEs, this will include all inspection and
　　　　　　　　　　administrative staff

FEDOSHINSP　　=　　The number of federal OSHA inspections that occurred in
　　　　　　　　　　that fiscal year

OSHABUDGET　　=　　The OSHA budget for that year adjusted to 2001dollars
　　　　　　　　　　using the CPI inflation calculator

Using the injury and illness rates for all sectors shows that there are statistically significant relationships with staffing and agency budget. Agency budget has an inverse relationship while staffing does not. However, when using the overall injury and illness rate, the number of inspections is no longer statistically significant. The above output shows that as OSHA's budget increases there is a decline in the number of injuries and illnesses. The lack of significance on the inspection variable (FEDOSHAINSP) and the positive sign on the staff level variable (OSHASTAFF) may be due to the tendency for a larger percentage of injuries and illnesses to be reported where there are more staff members doing more inspection. The effect of a higher budget captures the inverse relationship between OSHA agency activity and injuries and illnesses.

Penalty amounts should also have an effect on the number injuries and illnesses and the rates reported by BLS. As noted before, there was a change in the penalty amounts starting in 1991 where there was a seven-fold increase in the maximum penalty that OSHA could assess (FACT sheet 92-36). Using the BLS injury and illness data that indicates the total number of injuries and illnesses as reported by BLS for the OSHA years, resulted in the following OLS regression output. This output does not include 1972 because that year caused large leverage on the model and was the start up year for inspections.

$Injuries\_BLS = 7.8181129 + .0018551(OSHASTAFF) - .0194321(OSHABUDGET) + .0000147(penalties)$

(tail prob.) (.000)	(.000)	(.000)	(.000)
(tolerance)	.641	.576	.815

$R^2 = .686$ Adj. $R^2 = .653$ n=33   SEE = .437   D-W= 1.09

Where,

Injuries_BLS   =   BLS number of occupational injuries in millions

OSHASTAFF = Number of FTEs, this will include all inspection and
administrative staff

OSHABUDGET = The OSHA budget for that year adjusted to 2001dollars
using the CPI inflation calculator

PENALTIES = Penalty amount for OSHA violations adjusted to 2001
dollars.

This OLS regression results in an output that cannot be used because the Durbin-Watson Statistic is in the rejection region. Other variations of this model were explored and found no statistically significant relationship free from fatal autoregression. However, the above output used the overall number of injuries and illnesses and does not take into account the number of employee hours worked. In order to account for the number of hours worked, you must use the injury and illness rate. In addition, a dummy variable was also used to account for the increase in penalty amounts. Using agency factors such as budget, staff, and the penalty dummy variable in the OLS regression results in the following output:

Injury_rate = 10.6742890-.0309248(OSHABUDGET)+.0038062(OSHAstaff) -0.5862966(penaltydummy)

(tail prob.) (.000) (.000) (.000) (.078)

(tolerance) .356 .398 .585

$R^2 = .827$ Adj. $R^2 = .809$ n=34 SEE = .713 D-W= 1.83

Where,

Injuries_RATE = BLS injury rate

OSHABUDGET = The OSHA budget for that year adjusted to 2001dollars
using the CPI inflation calculator

OSHASTAFF   =   Number of FTEs, this will include all inspection and administrative staff

Penaltydummy   =   Variable used to account for the 1991 increase of penalties. 0 = years prior to increase and 1=years after increase.

This output indicates that the OSHA budget, OSHA staff and the penalty increase have a statistically significant relationship with the injury and illness rate. In this OLS regression, OSHA budget and the penalty dummy variable has an inverse relationship with the injury and illness rate. This indicates that the penalty increase in 1991 resulted in a decrease in the injury and illness rate. OSHA budget shows an inverse relationship with the injury and illness rate. Although staffing levels do not have an inverse relationship, the effect of staff may be captured by the budget variable. In addition, increased staffing levels may also find additional violations. As stated by Ruser and Smith (1990), "increase in inspection intensity increases the probability that an establishment violating a standard will be detected and cited."

Economic Factors and Their Impact on Injuries and Illnesses

Other variables that may also affect the number of occupational injuries and illnesses are economic factors such as GDP, median household income, and NSC costs. When using OLS with the number of injuries and illnesses as reported by BLS and economic factors resulted in with a Durbin-Watson Statistic in the rejection region. Another OLS regression was run using the injury and illness rate reported by BLS. This

regression also had a Durbin-Watson statistic in the rejection region. Alternative models were explored using variations on costs, income, GDP, lagged variables, and did not find a statistically significant relationship free from autoregression. In addition, other bi-variant models were also developed but did not result in a usable model free from autoregression or fatal multicollinearity.

$\text{Injury\_rate} = 2.1776073 + .0259944(\text{NSCCosts}) + .0003927(\text{INCOME}) - .0018616(\text{GDP\_2001})$

(tail prob.)	(.507)	(.000)	(.000)	(.000)
(tolerance)		.217	.134	.070

$R^2 = .883$ Adj. $R^2 = .870$ n=32   SEE = .570   D-W= .73

Where,

NSCCosts   =   Cost of occupational injuries obtained from NSC and adjusted to 2001 dollars

INCOME   =   Median household income obtained from CPS based on 2007 dollars

GDP_2001   =   GDP adjusted to 2001 dollars using the CPI inflation calculator

Workforce Factors and Injuries and Illnesses

Workforce factors such as the number of workers and number of unionized workers may also have an effect on the number of injuries and illnesses. An OLS regression was conducted using the total number of occupational injuries and illnesses reported by BLS and workforce factors. This resulted in the following output.

Injuries $= 14.0956137 -.0003748$(civilian workforce) $+ .0006376$(Female employed) $+.0001182$(union)

(tail prob.)   (.001)   (.001)   (.001)   (.381)

(tolerance)   .003   .003   .391

$R^2 = .324$ Adj. $R^2 = .256$ n=32   SEE = .662   D-W= .532

Where,

Civilian workforce   =   BLS civilian workforce employed in millions from the CPS

employed

Female employed   =   Number in thousands of females in civilian labor force

Union   =   Number of union members

This model is not valid because of fatal multicollinearity and the Durbin-Watson

Statistic is in the rejection region. In addition, other models were explored and did not

find a statistically significant relationship free from autoregression. In the models

explored using injury and illness data for all sectors, economic and workforce factors did

not produce useable models. However, useable models were developed using agency

factors.

Construction and Manufacturing

As discussed previously in this chapter, BLS has reported data on injuries and

illnesses for construction and manufacturing pre and post OSHA. Using data for

construction and manufacturing may give a more refined estimate of OSHA's impact on

injuries and illnesses in those industry sectors. Data reported before 1972 are in one

million hours worked and after OSHA, the rate was reported as number of recordable

injuries & illnesses/hours worked x 200,000 (100 employees working 2,000 hours per

year). For this reason, the rate was used for construction and manufacturing for the years

after the passage of the OSHA Act. Injury and illness rates for construction and manufacturing were used in the same regression models for agency, economic and employment factors to determine the effectiveness of OSHA.

Starting with construction, a model was constructed using agency factors such as the number of inspections, number of inspectors, budget (adjusted to 2001 dollars) and penalty amounts (adjusted to 2001 dollars) to predict injury rate for construction from 1972 to 2005. This resulted in the following output.

Injury rate const = 20.3297824+.0073951(OSHASTAFF)+.0000444(inspections)-.0686104(OSHA budget)- 0000317(penalties)

(tail prob.)	(.000)	(.000)	(.089)	(.000)	(.011)
(tolerance)		.448	.361	.439	.441

$R^2 = .860$ Adj. $R^2 = .839$ n=31   SEE = 1.36   D-W= 1.33

Where,

OSHA Staff   =   Number of FTEs, this will include all inspection and

administrative staff

Inspections   =   Number of federal OSHA inspections that occurred in that fiscal

year

OSHA Budget   =   Annual OSHA budget adjusted to 2001dollars

Penalties   =   Penalty amount for OSHA violations adjusted to 2001 dollars

In this output, the variables are statistically significant and the Durbin-Watson statistic is in the inconclusive range indicating acceptable autocorrelation. Two variables, OSHA budget and penalties have an inverse relationship with injury and illness rates in construction. Staff and inspections were also statistically significant but did not show an

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inverse relationship. A reason why budget shows and inverse relationship in all the models is that budget enables the hiring of inspectors and the initiation of inspections in the workplace. Staff does inspections, so that the strong inverse relationship shown in the budget variable is capturing the consequence of having more staff and inspections. In addition, penalty amounts had the expected sign, indicating that increases in penalty have an inverse relationship with injuries and illnesses in construction. OSHA penalties may have a greater deterrence effect in the construction sector because the businesses tend to be smaller and the penalty has a greater impact.

BLS also collected data on injuries and illnesses for manufacturing. Using the injury and illness rates for manufacturing, a model was constructed using the agency factors of the number of inspections, inspectors, budget (adjusted to 2001 dollars) and penalty amount (adjusted to 2001 dollars). This resulted in the following output for the injury rate in manufacturing.

INJRateMFG = 13.6496125 + .0058627(OSHASTAFF) + .0000308(Inspections) -.0499995(OSHAbudget) + .0000151(Penalties)

(tail prob.)	(.000)	(.000)	(.075)	(.000)	(.088)
(tolerance)		(.431)	(.477)	(.425)	(.468)

$R^2 = .789$ Adj. $R^2 = .758$ n=32   SEE = 1.052   D-W= 2.14

Where,

OSHA Staff   =   Number of FTEs OSHA staff including all inspection and
                            administrative staff

Inspections   =   Annual number of federal OSHA inspections

OSHA Budget   =   Annual OSHA budget adjusted to 2001dollars

Penalties   =   Penalty amount for OSHA violations adjusted to 2001 dollars

All of the variables in the above output were statistically significant. In this output, only OSHA budget shows that it has an inverse relationship with the injury and illness rate for manufacturing. However, the strong inverse relationship shown in the budget variable, is capturing a consequence of having more staff and staff conducting inspections. In addition, budget is used to fund staffing and in fiscal year 2007, 45% or approximately 220 million, of the OSHA budget was used for compensation and benefits of staff. In 1995, approximately 42% of the OSHA budget was used for compensation and benefits of staff. Other costs are associated with the function of the agency include rents for office space, utilities, supplies, equipment, and transportation costs. In fiscal year 2007, these costs were approximately 98 million or 20% of the budget.

Economic and Workforce Factors for Manufacturing and Construction

Economic factors were also used to determine if there is a relationship with GDP, median household wages and NSC costs and rates for construction and manufacturing. An OLS regression was run with variations of these economic factors. However, the models cannot be used due to autoregression. In addition, an OLS regression was also conducted using employee factors such as union membership and workforce and population demographics for construction and manufacturing. These models cannot be used due to autoregression. The results in the models for construction and manufacturing using overall injury and illness rates for economic and workforce factors were similar to the findings when using the overall rates and did not produce useable models.

Chapter Summary

The model used to develop a consistent time-series for occupational fatalities was useful for determine trends in occupational fatalities pre and post OSHA. The time-series corroborated the testimony that led to passage of the OSHA Act that fatalities had stagnated in the years leading up to the act. However, the OLS regression models developed to determine the effectiveness of OSHA on occupational fatalities did not have results that were statistically significant and free from autoregression. Clear conclusions about the impact of OSHA on occupational fatalities could not be drawn from these models.

Using the same variables in OLS regression models with occupational injury and illness data had different results. The agency variables did find statistically significant results free from fatal autoregression. OSHA budget had a statistically significant inverse relationship with all of the models explored. Variables for staff and inspections were also found to be statistically significant. It is likely that the budget variable captures the effect of inspections and staffing since those functions consume a large portion of the budget. However, economic factors and workforce factors did not result in models that were statistically significant and free from fatal autoregression. The significant coefficient in budget indicates that agency factors are contributing to the effectiveness of the agency in reducing injuries and illnesses.

The findings of this research confirm that the agency has had the desired impact on injuries and illnesses. In particular, OSHA budget was shown to have statistically significant inverse relationship with occupational injuries and illnesses. As discussed previously, budget does provide the resources for other agency factors such as

inspections and inspectors. This research confirms some of the findings in Bartel and

Thomas (1985) that identify reasons for the limited impact of OSHA at that time as being

related to "limited statutory and budgetary authority." An appropriate level of funding is

needed to enhance the effectiveness of the agency but the funding needs to be allocated to

the correct areas.

Other agency factors such as conducting inspections also use budget resources.

The inspections that have the potential to educate employers and detect hazards

associated with OSHA standards, which should lead to a reduction of injuries and

illnesses if the agency is effective. Funding inspections is an effective deterrence tool for

the agency to prevent injuries and illnesses. Gray and Jones (1990$_a$), found that a "10%

increase in inspections with penalties would reduce injury rates by 1%." In addition, in

the model using construction injury and illness rates, the penalty amount was an effective

deterrence tool for this sector.

This research found that the budget allocations for the agency have an effect on

injury and illness statistics. Budget allocations provide resources for all the enforcement

and outreach activities of the agency. This finding shows the importance of adequate

budget allocations for the agency to ensure that it is able to continue to reduce injuries

and illnesses. The following chapter will discuss policy implications of this finding and

other implications of this research.

CHAPTER V

DISCUSSION

Introduction

A primary objective of this study is to determine to what extent the Occupational
Safety and Health Act and the creation of OSHA, reduced occupational injuries, illnesses,
and fatalities. It was found that some agency factors had an effect on reducing the
number of injuries and illnesses reported by BLS. These factors include OSHA budget,
inspections, and penalties. Factors affecting occupational fatalities did not have as clear
an effect. There were indications that agency factors did have an effect on the overall
number of occupational fatalities however, the models were significantly autoregressive
and therefore could not be used to draw definitive conclusions. However, when
constructing a model using the year-to-year difference in the number of occupational
fatalities, the number of OSHA inspections was found to have the desired impact on
occupational fatalities. This finding indicates that an increase in inspections by 10,000
would reduce the annual number of fatalities by approximately 58 fatalities. This annual
reduction could eliminate the stagnation in the number of occupational fatalities since the
early 1990s.

In addition to agency factors, economic and workforce factors were also explored
to determine how they influence occupational injuries, illnesses, and fatalities. The
models developed using these factors did not show a statistically significant relationship
free from autoregression for occupational injuries and illnesses or fatalities. Thus,
conclusions could not be drawn from these models for fatalities or injuries. In addition,
models were explored using the year-to-year difference in the number of occupational

fatalities and economic and workforce factors. These models did not show a statistically significant relationship free from autoregression.

Summary and Explanation of Findings

Occupational Fatalities

One way proposed to determine the effectiveness of OSHA was to understand the impact the agency has on occupational fatalities. However, simply using an available data set that covered years prior to and after OSHA, proved to be impossible. The problem, as discussed in previous chapters, was changes in data collection methods by the reporting agencies. This study was able to develop an integrated estimated number of occupational fatalities using available data sets from three organizations. By using the overlap in coverage of the time-series, I was able to derive a conversion model to complete the series. For example, the incomplete NIOSH NTOF series that only covered 1980-1995 was completed to expand the series to span from 1929 to 2005. The expanded series were used to gain historical perspective of fluctuations in occupational fatalities over long spans of time.

One of the first steps in evaluating occupational fatalities was development of a time-series that encompassed the years before and after OSHA. This time-series was developed using available data from BLS, NSC, and NIOSH. This resulted in an estimated number of occupational fatalities that reconciled different data collection methods and was useful in evaluating the impact of OSHA in this study. This time-series provides an estimated number of occupational fatalities that takes into account the change in data collection and reporting of occupational fatalities that occurred with the BLS

adoption of the CFOI in 1992. In addition, this time-series also allowed for reconciliation of historical occupational fatality data prior to the implementation of the agency.

The reconciled time-series provides a data set that can be used to evaluate the impact of OSHA on occupational fatalities. In research that has looked at or has used occupational fatality statistics, the change in reporting and data collection is omitted, or only years prior to or after 1992 are used. For instance, Manuele (2008) discussed statistical indicators of fatalities and used a combination of National Safety Council (NSC) and BLS CFOI data. However, he does not mention that he is using two separate data sets with different collection methodology or the 1992 adoption of BLS's CFOI. Manuele goes on to say that, there has been a 67% reduction in the number of occupational fatalities from 1941 to 2001 (Manuele, 2008). This statement is in error because the method does not mention the change in data collection for occupational fatalities. As discussed in previous chapters, there were different organizations that collected fatality statistics. The 1941 statistic quoted by Manuele was from the National Safety Council (NSC), where the 2001 statistics were from the BLS CFOI. This common error is due to a lack of a reconciled data set for occupational fatalities.

This dissertation uses data from BLS, NIOSH, and NSC to calculate the estimated number of occupational fatalities. Using the estimated number of occupational fatalities established for this research, there was a 49% reduction in the number of fatalities from 1941 to 2001. Although this is a large decrease, it is not as large as reported by Manuele. The data as reported by Manuele, gives the impression that work places are "safer" or have improved more than they actually have. However, when using either method it must be understood that the actual number of workplace fatalities is unknown.

When evaluating the effectiveness of OSHA, it is important to have a consistent time-series of fatality data for the OSHA years. Using the number of fatalities as reported by Manuele from 1971 to 2001, results in a 57% reduction of fatalities during the OSHA years reviewed. Using the estimated fatalities as established by this research from 1971 to 2001, results in a reduction of approximately 31% in occupational fatalities. Even though the reduction in the number of occupational fatalities using the estimated number of fatalities is less than reported by Manuele, it is still a rather large reduction over a 30-year period and has the advantage that it may be a more realistic estimate of the actual reduction of the number of occupational fatalities.

However, some findings from Manuele (2008) are consistent with the findings of this research. One of those is that there has been a stagnation of occupational fatalities since about 2001. Overall, since the passage of the OSHA Act, from 1972 to 2005 the trend is for a reduction of 83 fatalities per year. The greatest reduction occurred from 1972 to 1990, with 126 per year. However, as discussed by Manuele (2008), the annual reduction in fatalities since 1991 has stagnated. The estimated number of fatalities shows a reduction of only 3.5 per year since 1990 confirming Manuele's assertion that fatality reduction has stagnated.

The development of the estimated time-series for occupational fatalities developed in this dissertation allowed for evaluation of the agency that reconciles historical fatality data. This permits an evaluation of occupational fatalities pre and post OSHA to determine trends. In addition, the time-series was also used to determine how agency, economic, and workforce factors affect occupational fatalities. One of the findings of this research is that reduction in occupational fatalities is not as great as

normally reported. This research also corroborates other research indicating that the reduction of the number of fatalities has stagnated. The estimated time-series developed for this dissertation allows more complete research of occupational fatalities because it reconciles different methods of data collection.

Agency, Economic, and Workforce Factors and

Their Impact on Occupational Fatalities

Agency factors were used in an OLS regression to determine what effect they have on the overall number of occupational fatalities. These agency factors included the number of inspections, number of inspectors, budget allocations, and penalties. It was expected that the agency factors variables would have an inverse relationship with occupational fatalities. However, the models developed using these factors did not show a statistically significant relationship free from autoregression for occupational fatalities. Thus, conclusions could not be drawn from these models for fatalities.

There may be many reasons why the models did not perform as expected or why the models were not valid. As discussed by Drudi, occupational fatalities are rare events (1997). Since these events, are rare and the cause's complex, it may be difficult to determine how effective OSHA has been by solely looking at occupational fatalities. In 2005, there were an estimated 5,177 occupational fatalities. Using the population of the United States in 2005 of approximately 232 million, occupational fatalities occur to 0.002% of the population or one out of every 45,000. With such a low number of fatalities, it is difficult to detect the true overall effectiveness of the agency.

Another method was also utilized to determine the impact of the agency on occupational fatalities. The year-to-year difference in the number of occupational fatalities was calculated and regressed with agency factors. It was found when using the year-to-year difference in the number of occupational fatalities that the number of inspections had a statistically significant inverse relationship free from autoregression. The model indicated that an increase in inspection of 10,000 per year would result in a reduction of 58 workplace deaths.

In addition, there have been studies that show how specific standards have reduced fatalities in specific industries. Suruda et al. (2002) conducted one of those studies on the impact of the trenching standard. In their research, they "examined fatal injuries from trench cave-ins in the construction industry for five year periods before and after the revision" to the standard. For the 5-years (1990-1995) after the standard was revised "there was a 2-fold decline in the rate of fatal injury after revision of the standard, which substantially exceeded the decline in other causes of fatal injury in the construction industry during that same period." This standard protects a specific subset of employees in the construction industry who work in trenches and excavations. As the authors state, "the decline in fatal injuries from trench cave-ins was substantially larger (66%) than that for other causes of fatal injury (27% decline) in the construction industry that were investigated by OSHA (Suruda et al., 2002)." Although this standard only protects a certain subset of employees who work in construction, it shows that a specific standard and enforcement efforts can have an impact on the fatalities.

Economic and workforce factors were also thought to be important components that affect occupational fatalities. However, using the estimated number of occupational

fatalities and the year-to-year difference in occupational fatalities in the regression

models with economic and workforce factors did not result in statistically significant

models free from autoregression. Other alternative models were explored and resulted in

the same outcome. Although the models did not find a relationship with economic

factors or workforce factors and occupational fatalities that does not necessarily mean

that there is no relationship. As was true of the affect of agency factors and the overall

number of fatalities, this may be due to having few fatalities making changes difficult to

detect.

Although the models developed did not show that agency, economic, or

workforce factors had statistically significant effects on the overall number of fatalities,

occupational fatalities did decline at a faster rate after the implementation of OSHA.

Before the passage of the act, occupational fatalities were declining at a rate of

approximately 69 per year. After the passage of the act, the average reduction in

fatalities increased to about 83 per year. Some of this may be due to the natural trend that

was occurring, however, it is hard to dispute that the agency may have had role in

accelerating the reduction in occupational fatalities. In addition, the year-to-year

difference in the number of estimated fatalities has an inverse relationship with the

number of OSHA inspections.

OSHA's Impact on Occupational Injuries and Illnesses

Although the models using the overall number of occupational fatalities were not

usable, models using agency factors with injury and illness data had interesting results.

The theme found in all the models using injury and illness data was that OSHA budget is

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statistically significant and had an inverse relationship with occupational injury data. This indicates that funding for the agency is a key factor in allowing the agency to meet its mission. However, other agency variables did not have this consistent inverse relationship with injury and illness data. A possible explanation for this is the strong inverse relationship shown in the budget variable, is that the budget variable is capturing a consequence of having a well-trained and paid staff conducting inspections and other agency variables such as inspections. The following section details the findings of the OLS regression models for occupational injuries and illnesses using agency, economic, and workforce factors. An advantage of using injuries and illnesses is their greater frequency of occurrence, thus making it easier to detect the true effectiveness of the agency.

A model developed using agency factors such as OSHA staff, number of inspections, and budget allocations did produce statistically significant results. This model shows that increases in the OSHA budget and the number of inspections did reduce the overall number of occupational injuries and illnesses. Simply stated, as budget and inspections increase there is a decline in the number of injuries and illnesses. The variable OSHA staff did not result in the expected sign. It was expected that increases in OSHA staff would have an inverse relationship with the number of reported injuries. The model resulted in a positive sign for OSHA staff indicating the opposite.

However, the strong inverse relationship shown in the budget variable is capturing a consequence of having more staff. In fiscal year 2007, 45% or approximately 220 million, of the OSHA budget was used for compensation and benefits of staff. In 1995, approximately 42% of the OSHA budget was used for compensation and benefits of staff.

In addition, other costs associated with the function of the agency including rents for office space, utilities, supplies, equipment, and transportation costs use budget resources. Although agency variables other than budget were not consistent, many of the effects of these variables were captured in the budget variable.

When using overall injury and illness rates, as provided by BLS, there were similar findings concerning agency budget and the affect on injury and illness rates. An advantage of using injury and illness rates is that the rates account for hours worked and changes in employment. Using the same model with the rates, OSHA budget had a statistically significant effect in reducing injury and illness rates. Even though, the number of inspections was not statistically significant and the measured effect of staff was positive instead of the expected negative effect.

In the models using overall injuries and illnesses and the overall rate for all sectors, increases in budget allocations resulted in the expected effect of reducing occupational injuries and illnesses. Only in the model using the numbers of injuries and illnesses were inspections found to have the expected inverse relationship with injuries and illnesses. However, there are many effects of the agency variables that are captured in the budget variable. OSHA staff conducts inspections and are compensated from the budget, thus indicating that the effect of OSHA staff is actually captured in the inspection and budget variable.

Increases in budget allocations resulted in the expected effect of reducing occupational injuries and illnesses. In addition to providing funding for staff, the budget also funds inspections, standards development, and training. The funding of the various agency factors enables the agency to meet its mission of reducing injuries and illnesses.

Increases in budget allocations to OSHA had the desired result of decreasing injury and illness rates.

In addition, outreach efforts also take budget resources to maintain. Two major outreach efforts led by the agency are the consultation program and the OSHA website. Each state is required to provide small employers with free safety consultation services. These services are to assist employers in identifying and correcting safety hazards in their workplace and receive funding from the OSHA budget. The OSHA website provides access to all of the regulations, letters of interpretation, compliance directives as well as training and information resources. Since budget had the expected statistically significant sign, this may indicate that in addition to enforcement efforts, cooperative and outreach efforts, and staff development are influencing occupational injuries. Although there is controversy about the cooperative and outreach efforts taking resource away from enforcement activities, many employers and employees find these efforts useful. Other outreach and cooperative efforts provide training to employees and business groups but also provide valuable training to OSHA staff. In addition, the website provides regulatory compliance standards and many training tools to assist employers and employees.

Although it may seem counter intuitive that staff increases result in more measured injuries and illnesses, this may be explained by examining the timing of staffing levels and the development of the agency. During the 1970s, OSHA staff was at its highest levels. It was also during this time that there were higher numbers of injuries and illnesses as compared to more recent years. The agency and regulations were new to many employers. Although the initial start-up regulations were promulgated in a short

time, subsequent compliance with those regulations could have been more complex for organizations. Employers needed time to understand and comply with the regulations. In addition, increases in staffing allow the detection of injuries and illnesses. More inspectors in the field should detect injuries and illnesses that otherwise may have gone unreported. However, another issue with the staffing variable is that there has been little fluctuation in staffing levels for the agency. This small fluctuation in staff makes it difficult to detect changes because of staffing.

The training process for compliance staff is also intense and uses budget resources. OSHA has formal process of training inspectors at the OSHA Training Institute (OTI). This formal training process includes classroom instruction and on the job training. The training process, along with hiring standards, led to the professionalization of the staff and more efficient and knowledgeable inspectors. Ensuring that the staff is well trained to recognize hazards and to investigate incidents allows for efficient use of the agency's time and resources and uses budget allocations.

The number of inspections was expected to have a negative effect on injuries and illnesses. Meaning that as the number of inspections increased there would be a decrease in the overall number of injuries and the injury rate. However, only the model using the overall number of injuries and illnesses resulted in inspections having the expected sign. There are many reasons why the number of inspections did not have the expected sign in many of the models using injury and illness data. Similar to staffing increases, inspections may increase when there are more injuries and illnesses reported. Thus, indicating that inspections are a reaction to injuries and illnesses. Another explanation is that additional inspections and inspectors will detect additional injuries and illnesses and

deter underreporting. In addition, when inspections showed their first decline in the early 1980s, injury and illness rates started to climb.

When conducting the OLS regression analysis it was also important to determine if penalties had an impact on the injury and illness rates. The agency uses deterrence theory in the form of agency inspections, citations, and penalties to deter employers from violating standards. If employers comply with the standards, the worksite will become safer, thus less injuries. However, penalties reach beyond the employer receiving the penalty and serve as a deterrence tool for all employers. Penalty amounts increased in 1991 to enhance the deterrence effect of the agency. In the model using injury rate and agency factors such as OSHA budget, staff, and a dummy variable to account for the penalty increase, found an inverse relationship with budget and the penalty dummy variable. This indicates that the penalty increase did result in a decrease in the injury and illness rates. This finding shows that larger penalties and the deterrence effect of the penalty had the desired effect on injury and illness rates. In addition, although inspections did not increase in the early 1990s, the penalties did increase and injury and illness rates started to decline.

Many other factors could influence injuries and illnesses in the workplace. However, since economic and employment factors did not produce useable models, the results of this study indicate that agency factors did have the expected effect on workplace injuries and illnesses. Another factor that may have led to the observed decline in rates is the mere presence of the agency. An organization knowing that the agency is present and that there is threat of a penalty that may have an adverse impact on the organization, could persuade the organization to look beyond compliance and look at

their overall safety function and taking a pro-active safety stance. Mundy (2003) also found that OSHA activity has "pushed safety to the forefront of business concerns for many industries."

BLS Injury and Illness Rates for Construction and Manufacturing

BLS collected data on injury and illness rates for construction. The OLS regression models were run using agency, economic, and workplace factors on the individual construction and manufacturing injury and illness rates. The models that used economic factors and workplace factors did not have statistically significant results that were free from fatal autoregression. However, as in the other models that used injury and illness data, agency factors did result in models that were statistically significant.

The OLS regression using the injury and illness rates for construction and agency factors such as OSHA staff, inspections, budget, and penalties resulted in a model free from fatal autoregression. OSHA staff, budget, and penalties were the three variables that were statistically significant. The number of inspections was not found to be within the level of significance in this model. The OLS regression for construction showed that as budgets and penalties increased injury and illness rates for construction decreased.

The construction industry has historically been an industry with a high proportion of occupational injuries and illnesses. It is likely that OSHA could cause detectable changes in this industry sector. In addition, this industry had much room for improvement and the impact should have been seen in the construction sector. The model using injury and illness rates for construction was the only model in which the penalty variable had an inverse relationship with the injuries and illnesses. One of the

reasons why this may be occurring is the large portion of construction firms are under 250 employees. Research conducted by Mendeloff & Gray (2005), found that employers with less than 250 employees improved their safety record the most after an OSHA inspection.

Using the OLS regression model with the injury and illness rates for manufacturing, also produced a statistically significant model free from autoregression. The variables in this model that were statistically significant were budget and staff. OSHA penalties and number of inspections were not statistically significant. However, only budget had an inverse relationship with the injury and illness rate in manufacturing. Similar to the finding when using overall injury and illness data, the effect of staffing and inspections may be captured in the budget variable.

Effectiveness of OSHA

OSHA has been given the task of trying to prevent occupational injuries, illnesses, and fatalities by enacting safety regulations and enforcing those regulations. Many of the hazards that the standards are attempting to mitigate, have been recognized for centuries. However, injuries, illnesses and deaths are still occurring. Throughout the history of the agency, questions have been asked about the effectiveness of the agency in reducing those adverse events. This dissertation looked at multiple factors that may affect the effectiveness of the agency. Workplace fatalities and injuries have a profound effect on the individuals and organizations impacted by such events. The problem of occupational fatalities, injuries, and illnesses has been noted throughout history. Writing from Hippocrates in the fourth century identified hazards of working with lead. Later

Georgius Agricola wrote about hazards in the mining industry in his seminal work *De Re Metallica.* Published in 1556, this work identified numerous hazards such as airborne contaminants and ergonomic hazards still observed today (Nims, 1999). More recently, Crystal Eastman and Alice Hamilton identified occupational hazards and their effects on the workers and their families (DiNardi, 2003).

This research has found a detectable contribution from OSHA in the reduction of occupational injuries and illnesses. This dissertation was able to show that in all of the models, agency budget has an inverse relationship with occupational injuries and illnesses. In addition, in some of the models, the number of inspections, staff, and penalty amount also showed an inverse relationship with injuries and illnesses. Other variables related to economic and workforce factors did not have a statistically significant relationship. In addition, when using the year-to-year difference in the number of occupational fatalities, OSHA inspections had the desired impact of reducing the number of occupational fatalities.

Agency History and the Research Findings

The history of the agency documents the policies that were implemented and the resulting effects on the agency and its mission. Many of these policies affected the operation of the agency and the agency factors, which in this dissertation showed an effect on overall injury and illness rates and the year-to-year difference in occupational fatalities. For instance, in the early 1980s, the numbers of inspectors and budget allocations were reduced per the Reagan Administration. As was shown in this research injury and illness rates started to increase. When reviewing agency factors it is important

to understand the political influences and their effects on these factors. The agency is required by mandates from Congress or from administrative agendas to change its operation. Although some of the changes were necessary, many changes were setbacks to occupational safety and protection of the workforce. Since its inception, the agency has been trying to find the balance between regulation and the free market. It is often targeted as being "bad" for business and is influenced by political agendas.

One of the first examples of how politics affected the agency occurred during the Carter Administration. At the start of the Carter Administration, the agency was on track to implement numerous new standards that would protect employees from occupational injuries and illnesses. In the beginning of the Carter Administration, new standards were implemented and current regulations were streamlined. However, as the economic woes of the late 1970's began to increase, the administration caved to the pressure to reduce the ambitious goals of the agency. The agency was viewed as causing an adverse impact on business at a time when many were struggling. After 1978, the agency issued only one new standard. In addition, inspections and budget allocations began to decline and injuries and illnesses stagnated. This stagnation in injuries and illnesses may have been due to perceptions that the agency was no longer a threat, thus eliminating the deterrence effect of the agency. The restraints that were placed on the agency prevented many health standards from being implemented at that time, exposing many employees to the risk of occupational disease. In particular, standards for carcinogens and noise overexposure, which were being developed in the late 1970s, were not implemented. In addition, as shown in this research, agency factors such as budget cuts do have an adverse impact on the effectiveness of the agency.

The agency continued to lose ground on reducing injuries and illness during the Reagan Administration. This administration looked at government regulation and in particular OSHA as a problem instead of a solution. During this administration, the number of employees was reduced by approximately 20 percent. In addition, other agency factors such as inspections saw a decline in the first few years of the administration and the budget was reduced. These trends were consistent with the Reagan philosophy of less government. However, this prevented improvements in the injury and illness statistics. Injuries and illnesses remained stagnant for the first term of the Reagan Administration but began to increase during the second term and into the H.W. Bush Administration.

The next major shift in the agency came with the Clinton Administration. The agency was supposed to become the model for government reinvention. Government reinvention was proclaimed as the way to make the government and its agencies work smarter and more efficiently. For OSHA, the reinvention process consisted of taking offices "off-line" to change the way the office worked. The reinvention process emphasized employee involvement in the workings of the agency. Although the number of injuries and illnesses started their downward trend at a slower rate in the early 1990s, occupational fatalities were stagnating. In addition, agency factors such as number of inspections continued to decline. The budget was not increased until the second Clinton term. Some of the reasons why the injury and illness rates declined during the Clinton Administration may have been the perceived strength of the agency during a Democratic Administration and eventual increases in the budget. In addition, penalties were increased in 1991, which led to a greater deterrence effect of the agency.

In the most recent Bush Administration, there was little movement with anything within the agency. During this administration, only one new standard was implemented. The reason this standard was implemented was to fulfill a court order to protect employees from chorme-6, a material found in certain metals that causes cancer. The emphasis during this administration was for cooperative efforts. Many resources were utilized for partnerships and voluntary compliance. Although injuries and illnesses continued to decline, occupational fatalities continued to hold steady. The G.W. Bush Administration had mixed influences on agency factors. The OSHA budget received an initial increase at the start of the administration. However, as time progressed the budget began to decline. Although an official reduction in force (RIF) was not implemented for the agency, staffing levels were also slowly reduced to 2,200 FTEs in 2005. In addition, inspections hovered at about 35,000.

Almost since its inception, OSHA had to bend to outside influences even when these outside influences contradicted the mission of the agency to protect the workforce. Sometimes these outside influences affected agency factors that have the potential to reduce injuries and illnesses and ultimately deaths. Future administrations need to find the balance between fair enforcement efforts and outreach and the goal of protecting the workforce. As shown in this dissertation, OSHA budget has a strong influence on occupational injuries and illnesses.

<div align="center">Occupational Safety Data Collection</div>

Occupational safety data collection was a concern in this research. The collection of data on occupational safety issues is a work in progress. Since the passage of the

OSHA Act, much advancement has been made in data collection strategies. With the passage of the Act, BLS was mandated to collect information on injuries, illnesses, and occupational fatalities. Concurrently, organizations such as NSC, also collected this data. However, this has caused issues when conducting comparisons of data, especially for fatalities.

The current method that BLS uses and NSC adopted in 1992 for collecting data on occupational fatalities is very good. The current method, referred to as the Census of Fatal Occupational Injuries (CFOI), uses multiple source documents to determine the number of occupational fatalities that occur annually. This method is an improvement from the survey-based system that was used prior to 1992. However, even with this method, there is a possibility that some occupational fatalities are missed.

Since there has been a change in the method of counting occupational fatalities, comparisons to years prior to the CFOI are difficult to make. This research was able to use data from NSC, NIOSH, and BLS to estimate the number of occupational fatalities and to make comparisons. It is important that researchers who evaluate occupational safety acknowledge and deal with the issue of changes in data collection methods by the reporting agencies for occupational fatalities.

In addition, data on occupational injuries and illnesses were also used. There have also been changes in the way that BLS collects this information. BLS has always used a survey-based method for the collection of injury and illness data. The most dramatic changes were ones where more detail were required and when the survey response became mandatory. However, with these changes, there were not dramatic shifts in the numbers presented since the passage of the OSHA Act. In essence, these

changes helped to eliminate bias from non-responders. The data on injuries and illnesses

from BLS was easily comparable for the OSHA years. However, the data collected

before 1972 did not include all states and was calculated in a different manner. This

made comparisons pre and post OSHA nearly impossible.

The importance of data collection for occupational injuries, illnesses, and

fatalities is paramount to determine OSHA's impact on safety in the workplace. The

mission of the agency is to prevent the occurrence of injuries, illnesses, and fatalities in

the workplace. BLS data collection on occupational fatalities improved greatly with the

development and implementation of the CFOI. BLS data collection of occupational

injuries and illnesses has been useful for comparisons during the OSHA years. Accurate

data is necessary to evaluate the effectiveness of the agency.

Improvements should be made to the data collection system. One improvement

would be to standardize the workers compensation system and collect data directly from

workers compensation reports. This would allow comprehensive data collection of

occupational injuries, illnesses, and deaths. Using a consistent workers compensation

structure would allow tracking of serious injuries and fatalities. This would require all

states to follow the same workers compensation reporting rules. Currently, workers

compensation rules vary from state to state. Even with this type of system, fraud or other

methods to hide injuries and illnesses could hinder definitive accounting. Problems

include employers who coerce employees into not filling a worker's compensation claim

and employers who do not have the proper insurance.

Another improvement is ensuring consistent reporting of occupational fatalities.

This could be as simple as having a standard death certificate format that has a category

indicating work-relatedness. However, if using a death certificate only method to account for occupational fatalities, procedures must be in place to ensure that occupational deaths are properly recorded. The current CFOI, which uses multiple source documents in addition to death certificates, is a very good method to count fatalities and is a great improvement over the survey-based systems previously used by BLS and NSC.

Future Research

There are multiple areas for future research on occupational safety topics and OSHA. Additional research on the effectiveness of the agency could focus on specific standards and their preventative effect on expected injury reduction. Another extension of this research would be to focus on budget allocation within the agency. This research looked only at the overall budget allocation and found that OSHA budget levels had statistically significant impact on injuries and illnesses. Future research could also extract in more detail exactly where budget monies are spent and specific line items in the budget. For instance, if OSHA resources are used for outreach efforts, is there a decrease in the rates in the targeted area? In addition, this could show how changes in agency emphasis from cooperative programs to enforcement activities affect the overall injury and illness rates and find a balance between those efforts.

Conclusions

A major policy recommendation derived from this research is that OSHA needs the funding resources to meet its mission and to reduce incidents of occupational injuries,

illnesses, and fatalities. In the models developed using injury and illness data, OSHA budget consistently showed a statistically significant inverse relationship with injuries and illnesses. One of the main findings of this research is that the agency needs to be adequately funded to prevent injuries and illnesses. Although the other agency variables did not have the expected inverse relationship in all the models, it is likely that the effect of those variables, such as inspections and staff, are captured in the budget variable. In addition, when using the year-to-year difference in the number of occupational fatalities, OSHA inspections were found to have the desired impact on fatalities. In order to conduct inspections, staffing and budget resources must be in place. Furthermore, if fatalities follow the classic loss control pyramid, then reducing injuries and illnesses will also reduce fatalities (Manuele, 2008). The classic loss control pyramid assumes that prevention of less severe incidents reduces the number of more severe incidents such as fatalities.

This and future research has the potential to guide policy makers on what works for the agency and what protects the workforce. Efforts to cut funding for the agency will have an adverse impact on injury and illness rates. As was seen in the early 1980s, when budgets were cut injury and illness rates began to increase. In addition, preventing injuries and illnesses should also help prevent occupational fatalities when following the classic loss control pyramid.

Providing a safe and healthful working environment should be the goal of all employers. Beyond the obvious financial costs to employers in form or workers compensation insurance, there is a moral imperative that efforts are made to reduce the risk of injury, illness, and death on the job. In addition, OSHA must find a way to meet

its mission of reducing fatalities and injuries in the workplace. This needs to be done in a way that benefits all of the stakeholders involved. In any case, it must be understood that those views, which are on the fringe of both sides of the debate, will probably disagree on how this should be accomplished. However, as shown in this dissertation, agency factors are having a measurable effect on occupational fatalities and injuries and illnesses.

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Appendix A – Explanation of Penalty Reduction Factors

When an employer receives a citation, many factors determine the actual penalty received. According to the act, the following factors must be considered when making the final penalty assessment for a violation of the act. These factors, gravity of the violation, company size, good faith, and inspection history must be taken into account when assessing the penalty for the violation (OSHA Act; Firm, 1999).

The gravity of the violation takes into consideration the severity of the injury that could occur and how likely it would be for that injury to occur. The severity of the injury is given a high, medium, or low ranking. In addition, the probability of the injury occurring is also considered. The probability is given a ranking of greater or lesser. When these factors are taken into account, a gravity-based penalty (GBP) is assessed.

Table A1- *Gravity Based Penalty (GBP) Chart for OSHA Assessed Penalties for Serious Violations (FIRM, 1999)*

Severity	Probability	GBP
High	Greater	$5,000
Medium	Greater	$3,500
Low	Greater	$2,500
High	Lesser	$2,500
Medium	Lesser	$2,000
Low	Lesser	$1,500

In addition, to the GBP, there are adjustment factors for size, good faith and history. According to the FIRM, "A maximum penalty reduction of 60 percent is permitted for small businesses. 'Size of business' shall be measured on the basis of the maximum number of employees of an employer at all workplaces at any one time during the previous 12 months" (Firm 1999). Table A2 gives the penalty reductions for size.

Table A2. *Percent Penalty Reduction for Size of the Establishment Inspected (FIRM, 1999)*

Number of employees	Percent Penalty Reduction
1-25	60
26-100	40
101-250	20
251 or more	0

The other two penalty reduction factors are good faith and inspection history. Good faith is based on a determination of the effectiveness of the employers' safety program and efforts related to safety at the facility. The employer could receive a reduction of 0, 15 or 25 percent penalty reduction based on their good faith efforts. In addition, if the employer has not received a serious violation in the past three years a 10 percent penalty reduction for history is also added.

An example of how the GBP system and penalty reduction factors reduce penalty amounts is as follows. An employer receives a violation that is a high greater. The employer receives a fine of $5,000. However, additional adjustment factors are

added to the final citation. The employer has 20 employees and has not had an inspection

with a serious citation within the past 3 years. The employer is not given credit for good

faith. The additional penalty reduction factors would include a 60 percent reduction for

size and a 10 percent reduction for history for a total reduction of 70 percent. According

to table A3, this would give the employer a final penalty amount of $1,500.

Table A3-*Penalty Amounts for Serious Violations Using Gravity Based Penalty System (FIRM, 1999)*

Percent Reduction	GBP Penalty in Dollars							
0	1,000	1,500	2,000	2,500	3,000	3,500	5,000	7,000
10	900	1,350	1,800	2,250	2,700	3,150	4,500	6,300
15	850	1,275	1,700	2,125	2,550	2,975	4,250	5,950
20	800	1,200	1,600	2,000	2,400	2,800	4,000	5,600
25	750	1,125	1,500	1,875	2,250	2,625	3,750	5,250
30	700	1,050	1,400	1,750	2,100	2,450	3,500	4,900
35	650	975	1,300	1,625	1,950	2,275	3,250	4,550
40	600	900	1,200	1,500	1,800	2,100	3,000	4,200
45	550	825	1,100	1,375	1,650	1,925	2,750	3,850
50	500	750	1,000	1,250	1,500	1,750	2,500	3,500
55	450	675	900	1,125	1,350	1,575	2,250	3,150
60	400	600	800	1,000	1,200	1,400	2,000	2,800
65	350	525	700	875	1,050	1,225	1,750	2,450
70	300	450	600	750	900	1,050	1,500	2,100
75	250	375	500	625	750	875	1,250	1,750
85	150	225	300	375	450	525	750	1,050
95	100	100	100	125	150	175	250	350

The GBP is what the employer will receive if there is a citation issued for a

violation of a standard. However, the employer may also have the penalty lowered from

the GBP during an informal conference or by contesting the citation.