

The U.S. Air Bag Regulations – An Evaluation of Public Policy

by

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in Partial Fulfillment of the Requirements for the Degrees of

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and
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ABSTRACT

This thesis deals with the questions of government regulation of road traffic safety. It examines the policies of the United States federal government to mandate the installation of automatic occupant restraints in automobiles as a case study.

The history of occupant restraint regulation is first reviewed, followed by an introduction of a framework to examine the appropriateness of possible countermeasures to improve occupant protection. Two perspectives -- those of the individuals and the society -- are contrasted and the economic rationale for governmental intervention to market failure is examined.

The usefulness and limits of tools for evaluating countermeasure programs -- cost-benefit analysis and cost effectiveness analysis -- are discussed, and a review of how these tools are used in actual policy formulation is presented.

Finally, the experience of the United States is compared to other countries' approach to the problem; this is followed by a summary and conclusions.

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List of Acronyms and Definitions

Acronyms

DOT: The U.S. Department of Transportation.

FMVSS 208: Federal Motor Vehicle Safety Standard 208. The standard which specifies the performance of occupant crash protection.

ISTEA: The Intermodal Surface Transportation Efficiency Act of 1991.

NHTSA: The National Highway Traffic Safety Administration, an agency within the DOT.

NTSB: The National Transportation Safety Board, a federal oversight agency.

OMB: The Office of Management and Budget.

Technical Definitions

Air Bags: An occupant restraint system consisting of a fabric bag that is rapidly inflated with gas in the event of a collision to prevent the occupant from hitting the vehicle interior. The legal definition is rather puzzling. In the ISTEA of 1991 (Section 2508), certain types of automobiles manufactured after specified dates were required to have “inflatable restraint complying with the occupant protection requirement” in front outboard seating positions. According to this law, NHTSA states in the FMVSS 208 as amended on September 2, 1993 (58 Federal Register 46551) that “an inflatable restraint means an air bag that is activated in a crash.” Other than this statement, FMVSS 208 sets only performance standard for occupant crash protection.

Seat Belts: An occupant restraint system consisting of a belt or belts that are fastened round an occupant to prevent the occupant from hitting the vehicle interior in the event of a collision. FMVSS 208 categorizes seat belts into type 1 seat belt assembly (commonly known as 2 point or lap only belt) and type 2 seat belt assembly (commonly known as 3 point belt consisting of both a lap belt and a diagonal torso (shoulder) belt).

Automatic (Passive) Seat Belts: Automatic seat belts require no buckling by the occupants as belts apply automatically. Alternatively called as passive seat belts. Several variations exist such as motorized or non-motorized, and 2 point or 3 point.

Ignition Interlock: This system consists of an electric linkage between seat belts and an ignition switch with simple sensors beneath the front seat; it prevents a car from being started with unbelted front seat occupants.

Automatic (Passive) Restraint: An occupant restraint system that requires no action by the occupant to become effective. Air bags and automatic seat belts were the two major examples of systems that comply with FMVSS 208 for passenger vehicles of model year 1990-1997 and light trucks of model year 1995-1998. For passenger cars of model years 1998 or later and for light trucks of model year 1999 or later, the combination of air bag and manual lap/shoulder belts is the only equipment that complies with FMVSS 208.

Automatic (Passive) Restraint Regulation: A series of regulations on FMVSS 208 that requires the installment of automatic (passive) restraint in certain types of vehicles is collectively called, in this thesis, as automatic (passive) restraint regulation, or simply called air bag regulation.

Light Trucks: truck, bus and multipurpose vehicle (other than walk-in van-type trucks and vehicles designed to be exclusively sold to the United States Postal Service) with a gross vehicle weight rating of 8,500 pounds or less and an unloaded vehicle weight of 5,500 pounds or less.

Chapter 1

Introduction

From the late 1960s until recently, the air bag as an automatic restraint in motor vehicles was the focus of long and fierce controversy in the United States. This thesis evaluates the public policy of the United States that ultimately mandated in 1993 the installment of air bags in automobiles as a safety device.

Motivation Underlying the Research

There are several reasons to study this topic. First, road traffic accidents are undeniably a major problem that plagues our society. Every year in the United States, about forty thousand people die, and more than a million incur nonfatal disabling injuries. Moreover, unlike major life threatening diseases such as cancer and heart diseases that affect elderly people, road traffic accidents are likely to deprive the lives of younger people, which implies more tragedy than the sheer number of fatalities implies. Consequently, the potential impact which a countermeasure like the air bag has on the physical consequence of traffic accidents could be substantial.

Second, due to the widespread use of automobiles in daily life, countermeasures to improve road safety have an impact not only on people's health but also on their checkbooks and mobility. Moreover, the automobile industry is one of the most influential players in the U.S. national economy. Creating a balance among these conflicting interests and objectives

inevitably involves political decisions. The air bag regulation was a typical example. It took an extraordinarily long time for the mandate to finally be written into the standard. Extremely fierce debates that involved all three branches of the government, as well as industry, consumer advocate groups and lay people, were part of this process. Reviewing the process might be of use to similar cases.

Finally, though the controversy over the air bags seems to have been settled in the United States, the air bag has not yet been mandated in other parts of the world. Many countries, instead, mandated the use of seat belts earlier than the United States. The major motivation of the air bag mandate is that people in the United States do not use seat belts and that making them buckle up was difficult. This contrast may reflect the difference in the relationship between individuals and society in the United States, as compared to other countries, and thus is worth exploring.

Problem Definition and Methodology

This thesis is based on extensive literature review, and addresses three major questions: (1) What is an appropriate framework to assess the regulation that forces the installment of air bags in automobiles?; (2) How can the framework be applied in practical policy making?; and (3) Why did the United States lead in mandating the air bags as compared to other nations?

Background Knowledge of Occupant Restraint Systems and the Regulations

Before delving into the history of automatic restraint regulations, it is useful to briefly describe the current regulation and various occupant restraint systems developed to comply with the standard. Major characteristics of each system is tabulated in Table 1-1.

FMVSS 208

Federal Motor Vehicle Safety Standard (FMVSS) No. 208 sets the standards for occupant crash protection in automobiles. Originally, it was a standard that required the installation of manual seat belts. As amended in 1984, the standard required 10% of passenger cars in model year 1987, 25% in model year 1988, 40% in model year 1989, and all cars manufactured after September 1, 1989 (model year 1990) to be equipped with automatic crash protection for occupants for front outboard seating positions, which require no action by the occupants to become effective. Air bags and automatic seat belts are examples of eligible systems. To encourage the installation of air bags (originally for drivers only and later for passengers), Standard 208 exempts the right-front passenger position from automatic protection until September 1, 1993, if an air bag (or non-belt technology) is installed for the driver; thereafter, automatic protection is required at both positions in all cars.

As amended in 1993 according to a requirement of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, standard 208 required 95% of passenger cars manufactured after September 1, 1996 and

all passenger cars manufactured after September 1, 1997 to have driver and passenger air bags, plus manual lap and shoulder belts.

In 1991, National Highway Traffic Safety Administration (NHTSA) extended the automatic occupant protection requirements to light trucks and vans, on a phased-in basis. (model year 1995-1998). As amended in 1993 according to the ISTEA of 1991, the standard required these vehicles to have driver and passenger air bags, plus manual lap and shoulder belts by September 1, 1998.

Required performance of occupant restraint systems is measured by frontal or near frontal (plus or minus 30 degrees) barrier crash tests at 30 miles per hour in which test dummies, both belted and unbelted, must remain in the vehicle and must meet specified injury criteria for the head, chest, and femur.

In this thesis, the series of rules are collectively called automatic (passive) restraint regulations or simply, air bag regulations in that they eventually required air bags themselves.

Air Bag

The air bag is a fabric cushion that is very rapidly inflated with gas to cushion the occupant and prevent him or her from colliding with the vehicle interior (so called “second collision”) when a crash occurs that is strong enough to trigger a sensor in the vehicle. Generally, the bag will inflate at a barrier equivalent impact speed of about 12 miles per hour or greater. After a crash, the bag quickly deflates to permit steering control or emergency egress. (NHTSA, 1984)

There are several characteristics that make air bags distinct from the other types of occupant restraints. First, air bags, unlike manual seat belts, require no action by vehicle occupants to become effective, and thus are called an “automatic restraint system.” Second, occupant protection given by air bags covers a relatively small fraction of crashes when compared with seat belts. Air bags deploy only in frontal or near frontal crashes at barrier equivalent speed of about 12 miles per hour or greater, and are designed not to deploy in side, rear or rollover crashes. In a crash that involves multiple impacts, air bags deploy only once. For these characteristics, air bags are now regarded as a restraint that “supplements” seat belts. Third, air bags are relatively expensive compared with manual or automatic seat belts defined below. Though, as discussed later, it is not easy to know the true costs of air bags, it is generally agreed that full front air bags costs in the order of several hundred dollars. (NHTSA, 1992b)

Cars installed with air bags are rapidly increasing. In 1994, the share of air bags in new car registration was 34.7 percent for driver only air bags, and 49.03 percent for dual air bags, and cumulative registration of air bag installed cars exceeded 20 million. (NHTSA, 1996)

Automatic Seat Belts

Automatic or passive seat belts require no buckling by the occupants as belts apply automatically. Automatic belts were first developed by Volkswagen to meet the automatic restraint regulation and were experimentally installed to 1975 and 1976 models of the VW Rabbit (Golf) in the United States. In the 1980s several types of automatic belts as shown

below were developed and installed by many auto makers. During 1987 and 1994, about 27 million new cars were installed with some kind of automatic seat belts. (NHTSA, 1996)

- Motorized 2 point (shoulder) belt without disconnect, plus manual lap belts -- the motors automatically move the shoulder belts onto place when the ignition is turned on; the belts can be loosened but not disconnected in emergency egress situations.
- Motorized 2 point belts with disconnect, plus manual lap belts -- they resemble the preceding type, but they can be disconnected rather than just loosened.
- Nonmotorized 3 point (lap/shoulder) belts with disconnect -- the door-mounted belts automatically move into place when the doors close; they can be disconnected.
- Nonmotorized 2 point belts -- the door-mounted belts automatically move into place when the door close -- plus manual lap belts and-or knee bolster; most can be disconnected.

In 1991, the ISTEA specified that the automatic restraint installed in all new passenger cars after September 1997 and in all new light trucks sold in September 1998 and later must be inflatable restraints (i.e. air bags), thereby prohibiting the use of automatic seat belts as a means of complying with the regulation. Automatic seat belts have commanded a diminishing share of the new car market. In 1994, the share of automatic seat belts new car registration was about 16 percent, and the share will continue to shrink as time passes. (NHTSA, 1996)

The cost of automatic seat belts depends on their design. A nonmotorized 2 or 3 point automatic belt was estimated to add \$40 to the

cost of manual belts. Motorized belts are more expensive than nonmotorized ones and they cost about \$150 more than the manual belts. (NHTSA, 1984)

Manual Seat Belt

Though manual seat belts as vehicle equipment is not discussed in this thesis (their use by occupants is discussed), we briefly review it as background knowledge. Manual seat belts have a long history. Seat belts were developed in the 1880s to keep people from bouncing off horse-drawn buggies. In the 1950s several automobile manufacturers began offering seat belts in production vehicles in the United States. In 1961, some states began requiring installed seat belts in new cars sold in their states. In 1964, U.S. manufacturers began making front seat belts standard equipment in their cars, although shoulder belts were in only a few cars. By 1966 about 30 states had laws requiring front seat belts in all cars sold in their states.

In 1964, the Congress directed the Administrator of the General Service Administration (GSA) to set safety standards for cars purchased by the federal government. Among the first GSA standards were performance requirements for the strength and quality of safety belts and anchorage.

After the National Traffic and Motor Vehicle Safety Act of 1966 was enacted, the new federal motor vehicle standards that became effective in January, 1968 required the installation of shoulder belts in both front outboard seating positions and lap belts for all positions and specified minimum strength and quality of belts and anchorage.

By 1972, these lap and shoulder belts were unified so that single buckling would provide restraint for both the pelvis and the torso. An

important further refinement was the development of the emergency locking retractor, which allows only as much belt as is needed to be paid out and the rest is stored on a reel. Spring tension and an inertial sensor locks the belt in the event of a collision while allowing the passenger freedom of movement during normal situations. This function became mandatory in the mid 1980s.

Although seat belts were installed in all new cars and above refinements were added, relatively few people used seat belts. According to NHTSA's survey of belt use in 19 cities, overall driver's use of seat belts in 1982 was 11 percent. After states began mandating the use of seat belts, the use rate increased substantially. In 1994, the population-weighted average of observed seat belt use rate reported by states was 67 percent.

The cost of a seat belt system for two front seats and two rear seats is estimated to be \$150 dollars per car. (Graham, 1989)

Table 1-1 Characteristics of Different Occupant Restraints

	Air Bags	Automatic Seat Belts	Manual Seat Belts
Deployment	Automatic	Automatic	Manual
Technology	New	Mixed	Old
Use rate	High (nearly 100%) *	Medium (depends on configuration)	Low (approx. 60%)
Protection	Frontal Impact only	All Direction	All Direction
Cost	\$320 (in addition to the cost of manual belts)	\$40 - \$150 (in addition to the cost of manual belt)	\$150
Other remarks	Supplement of seat belts. (Should be used with belts.)	Several variations (2pt. or 3pt., motorized or not)	

* Though air bags do not require occupants' action to be deployed, there is a slight possibility that air bags will not deploy due to malfunction, or because they are not replaced after deployment due to the high cost of replacement.

Effectiveness of Occupant Restraint Systems

Effectiveness of occupant restraint system is measured by how much reduction in the chance of injury or fatality an occupant using the particular system will experience, compared to an unrestrained occupant, given that a crash has occurred.

There has been much debate on how much each system is effective, especially concerning air bags which had little real world experience. Table 1-2 shows the estimates of effectiveness by NHTSA when the automatic restraint standard was finally promulgated in 1984.

Table 1-2 NHTSA's Estimate of Percent Effectiveness of Occupant Restraints

	Manual Lap Belt	Manual Lap/Shoulder Belt	Automatic Belt	Air Bag Alone	Air Bag w/ Lap Belt	Air Bag w/ Lap/Shoulder Belt
Fatalities	30-40	40-50	35-50	20-40	40-50	45-55
AIS 2-5 Injuries	25-35	45-55	40-55	25-45	45-55	50-60
AIS 1 Injuries	10	10	10	10	10	10

Source: NHTSA, 1984

Note: AIS stands for Abbreviated Injury Scale. The scale used in the analysis is based on the following AIS 1976 definitions.

- AIS Injury Level
- 0 No injury
- 1 Minor (e.g., simple cut and bruises)
- 2 Moderate (e.g., simple fracture)
- 3 Serious (e.g., compound fracture or dislocated major joints)
- 4 Severe (e.g., amputated limbs, depressed skull fracture, survivable organ injuries)
- 5 Critical (e.g., major spinal cord injury, critical organ injuries)
- 6 Maximum, currently untreatable

While virtually all AIS 6 injury and over 50% of all AIS 5 injuries result in fatalities, it is not unusual for an AIS 3-4 injury to result in fatality to an elderly person or a person with special medical problems.

Structure of Thesis

This thesis consists of six chapters. Chapter 2 describes the history of the automatic restraint regulation in the United States, which took more than twenty years to be promulgated. Chapter 3 explores the framework to assess the appropriateness of the automatic restraint regulation, examining different perspectives to assess this question. Chapter 4 describes the practical aspects of regulatory analysis focusing on the effectiveness evaluation of the regulation which is conducted before and after the

regulation is promulgated, examining to what extent the framework described in chapter 2 is relevant in the real world. Chapter 5 places the experience of the United States in an international perspective. It addresses the question: Why did the United States lead in mandating the air bag? Chapter 6 presents a summary and conclusions, and gives suggestions for future research.

Chapter 2

History of the Automatic Restraint Regulation

In this chapter we review the history of automatic restraint regulation in the United States. Automatic restraint regulations had a very long and intricate history, and while it is beyond the scope of this thesis to completely analyze the political forces behind the regulation in great detail, brief explanations are made with the description of major events.¹

Actors in the automatic restraint regulation are first introduced; then the major events and the background information is described. A chronology of the events are shown in Table 2-1.

¹ Readers interested in the details of the political aspect are referred to Graham (1989).

***Actors in the Automatic Restraint Regulation:
Their Roles and Views***

Several actors participated in the controversy on automatic restraint regulation: the regulators, automobile manufacturers, air bag manufacturers, the insurance industry and congresspersons. We will introduce these actors and their general view towards the automatic restraint regulation.

The Regulators

The National Highway Traffic Safety Administration (NHTSA -- formerly, the National Highway Safety Bureau) was established by the National Traffic and Motor Vehicle Safety Act of 1966 to promulgate safety standards for automobiles under the growing severity of road traffic accidents and the increasing political significance of the problem.

NHTSA has been the most strong champion of the air bags and automatic restraint standard, believing that passive measures designed to protect public health are more successful than active ones like conventional seat belts. (Nash, 1981) NHTSA argued that manual seat belts, though effective to protect occupants when they are used, was not actually protecting occupants because people simply did not use them.

Automobile Manufacturers

Automobile manufacturers began air bag research in the 1960s, and, in collaboration with auto parts manufacturers or by their own, developed prototypes of air bags. Even after the federal government proposed a rulemaking for air bags in 1969, automobile manufacturers' view towards the air bag was generally favorable. However, by 1973, automobile manufacturers attitudes towards air bags changed dramatically (Tolchin, 1984) and they became the only major organized opposition to the implementation of the automatic restraint regulation. They expressed concern about the costs of adding automatic restraints as standard equipment and what this would do to the demand for their product (i.e. automobiles). Their assumption was that consumers would not appreciate the benefit of automatic restraint, which seemed likely judging from the low use rate of seat belts, so that the manufacturers would not be able to pass the cost of passive restraint on to the consumers, if the manufacturers want to keep the demand level high.

Before the regulation was implemented, not enough automobiles were equipped with automatic restraints to determine whether this concern was correct, and much less possible to know the magnitude of impact. When the regulation was postponed for one year in 1981, NHTSA justified its decision based on the analysis on the adverse effect to automobile manufacturers. (NHTSA, 1981) One researcher, however, contended that the adverse impact would be minimal, and that it is even conceivable that the industry would benefit from implementation of the regulation depending on how the consumers would value the automatic restraints (NHTSA, 1984). Twelve

years have passed since the final decision on the regulation in 1984, and it is still not easy to conclude which prediction was correct, but what is at least clear is that the manufacturers changed their strategy and made safety a marketing tool for their products.

Another, and perhaps more serious concern of the automobile manufacturers was that the product liability litigation related to the air bag, even if it deploys as intended, would intolerably increase. The Safety Act of 1966 has ambiguous provisions on whether the compliance with the FMVSS shields manufacturers from product liability litigation. Some manufacturers were sued for not providing air bags, and another manufacturer was sued for an air bag that did not deploy in a low speed collision. (Certo, 1994) State courts have made conflicting decisions to various product liability cases on air bags. It remains to be seen whether the decisions of state courts will converge or not. What is clear so far is that the litigation fear of manufacturers may be well-founded.

Air Bag Manufacturers

Some entrepreneurial companies began researching air bags in the 1960s. Eaton, Yale and Town Inc., a diversified industrial supplier (now the Eaton Corporation), began air bag research in 1964, and in collaboration with Ford, developed prototypes. Researchers at the Thikol Chemical Corporation (later Morton-Thiokol, and now Morton International) began experiments in 1968 using pyrotechnics to inflate air bags. Allen Breed, a New Jersey mechanical engineer, developed a reliable mechanical crash sensor.

Air bag manufacturers were certainly the ones who would be better off as a result of the mandating of their products. Some early entrepreneurs of the industry could not survive the long delay of the regulatory process and withdrew from the enterprise. The most notable examples were Eaton Corporation and Allied Chemical Corporation, which gave up in 1978. However, those remaining achieved considerable growth after the implementation of the regulation. Morton International Corporation and Breed Technologies, Inc. had estimated net income of \$269 million and \$66 million, respectively in 1994. (Sherman, 1995, Murphy, 1995)

The political role of air bag manufacturers in the rulemaking of automatic restraint was less conspicuous than that of the automobile manufacturers. One reason for this is their relatively small size compared to that of automakers. Other reason may be that air bag manufacturers were the suppliers to the automakers, and thus they could be less vocal, even they might strongly hope and believe that the rulemaking should be hastened. However, it is clear that air bag manufacturers were the actors which contributed to the eventual maturation of the air bag technology and to the provision of information to the regulators.

Insurance Industry

The insurance industry has been a strong advocate of the air bag regulation from the early days of the history of air bags. It is generally agreed that the insurance industry would be the winner in air bag regulation at least in the short term. If the fatality and injury claims decrease as a result of air bags, the profit of insurance industry is supposed

to increase because the premium adjustment is usually delayed by several years.

One report explains the industry's support for air bags by the shift of claims from bodily injury to physical damage, which air bags will induce. Physical claims are more predictable than bodily injury because physical claims are unlikely to lead to litigation with unpredictable jury awards. Thus physical claims are better business to insurance companies. (Kneuper et al., 1994)

In the long run, the well-being of insurance industry will depend on how far the overall amount of claims declines as road gets safer with air bags. As long as the air bags will not reduce the fatality and injury claims below a certain limit where the decline in the amount of total business will affect adversely the profit of the industry, and which is unlikely, the insurers can benefit from short term gap between the premium and payout, and from the shifts of claims from bodily to physical damage.

Safety Advocates

The safety advocates represent the viewpoint of the consumers. Ralph Nader is one of the most notable examples. Their fundamental belief is that the interest of private corporations, i.e. the pursuit of profit, is naturally in conflict with consumers' concerns such as safety, and that strict governmental regulations should be imposed on the industry to protect consumers. In the history of automatic restraint regulation, safety advocates played a critical role in raising people's consciousness of the safety of automobiles as we will discuss in chapter 5.

History of the Regulation

This section describes the major events and the background information of the history of the automatic restraint regulation. Table 2-1 shows the chronology of events.

Table 2-1 Chronology of Major Events Concerning the Automatic Restraint Regulation

1952	August	First patent of air bag was filed.
1966	September	National Traffic and Motor Vehicle Safety Act of 1966 enacted.
1969	July	Advanced Notice of Proposed Rulemaking; deadline: January 1972.
1970	May	Notice of Proposed Rulemaking; deadline: January 1973.
	November	Proposed deadline for full protection: July 1973.
1971	March	Deadline: August 1975.
	April	Court Challenge (Chrysler vs. DOT).
1972	February	Ignition interlock permitted.
1974	August	Congress rejects interlock.
1975	August	Deadline: August 1976.
1976	December	Secretary of Transportation Coleman announces demonstration plan.
1977	June	Secretary of Transportation Adams announces new deadline: September 1981.
	September	Congressional hearings.
1978		Some air bag makers drop out from business.
1981	November	NHTSA announces rescission of the regulation.
1982	March	Court challenge (State Farm vs. DOT).
	June	Court of Appeals rejects NHTSA decision.
1983	June	Supreme Court rejects NHTSA decision.
1984	July	Secretary of Transportation Dole announces new deadline: September 1989 (with rescission provision related to mandatory belt use laws)
1986	June	Ford's petition to delay full front passive protection until 1994.
1989	April	Rescission provision expires.
1991	March	Extension of the rule to light trucks, deadline: September 1997.
1991	December	Congress requires NHTSA to mandate full front air bags.
1993	September	NHTSA mandates full front air bags. Deadline: September 1997 (passenger cars) September 1998 (light truck)

Before 1969

First Patent of the Air Bag

The idea of the air bag dates back to 1952 when the first patent was filed by John W. Hetrick. Ford and General Motors began development work on the air bag in the late 1950s. Early research efforts found that the two challenges are the accurate sensing of crash and the means of quickly inflating the bag. By the middle of 1960s, Eaton Corporation had begun cooperative development work with Ford, and in 1967 Eaton announced that it had developed a viable occupant protection system.

Safety Act of 1966

In 1966, with the enactment of the National Traffic and Motor Vehicle Safety Act, the federal government established a new regulatory structure for the safety of new motor vehicles. The National Highway Safety Bureau (which later became National Highway Traffic Safety Administration (NHTSA)) was organized and assigned the task of promulgating the Federal Motor Vehicle Safety Standards. (FMVSS) Underlying this movement were the growing severity of road traffic accidents and the increasing political significance of the problem. Given the major traffic growth rate at the time, the predicted human carnage was awful. At the same time, a trend of thought had emerged that vehicle design, rather than human behavior, was the key to safety improvement. Some congresspersons adopted this school of thought and began advocating for a new legislation that would force automobile manufacturers to invest

more for the safety of their products. It did not take much time for the proposed legislation to get finally approved.

1969-1972

First Series of Proposals

The newly established NHTSA first showed an interest in air bags in 1968. In 1969, it indicated the first intention of making an automatic restraint regulation. The concept of the new regulation was: (1) “passive” or automatic restraints, which requires no voluntary action by the user; and (2) inflatable restraints or air bags (i.e. the compliance technology was specified). The proposed effective date for the regulation was January, 1972. In the first public meeting following the notice, the agency stated that, charged with the task of reducing highway deaths and injuries, and faced with the low seat belt usage rates², it considered the air bag “the most promising restraint system. . . seen to date.” This was the beginning of the fifteen year controversy on the automatic restraint regulation.

Although manufacturers claimed that the lead time was not sufficient to resolve many technical problems, their reaction to the concept of air bags was generally positive. (NTSB 1979) The manufacturers’ support for the air bag in the late 1960s and subsequent abrupt abandonment of the support in the early 1970s is somewhat puzzling. Several explanations have been offered. One possibility was the changing fortune of the automobile industries: they began to foresee the threat of

² From 1970 to 1980 the rate of safety belt use among motorists in the United States was persistently low, less than 20 percent based on numerous roadside surveys. (Grimm, 1980)

serious Japanese competition as well as the new forms of regulations such as for exhaust emissions, and the diminishing resource to allocate to the air bag development. (Tolchin, 1984)

Another factor in their change of mind could be the realization of the magnitude of problems that would have to be overcome, such as the danger to standing children, excessive noise, liability risk in cases of failure to deploy or inadvertent deployment, and uncertain system longevity. (Graham, 1989) From the early stage, there was a skepticism about the feasibility of air bags among engineers of auto manufacturers. As the development of air bag proceeds, these problems began to be recognized more realistically by engineers and management, and wiped out their early optimism.

In May 1970, NHTSA issued a first formal proposal for rulemaking. In order to satisfy the requirement of the Safety Act of 1966 that safety standards specify the levels for vehicle performance rather than prescribing specific design, NHTSA described a basic injury criteria expressed as maximum forces allowed on critical parts of the human body, which were to be measured by the anthropomorphic testing dummy. Recognizing the difficulties manufacturers might have in complying, the NHTSA deferred the deadline by one year to January 1973, after which all passenger cars were to be required to offer full passive protection.

In November 1970, NHTSA deferred again in response to the manufacturers' request for additional time, and announced that the deadline for front-seat passengers was set at 1 July 1973, and passive protection for rear occupants was mandated after 1 July 1974.

In March 1971, another amendment was announced. In response to the motor manufacturers petitions, NHTSA allowed options for vehicles manufactured between 15 August 1973 and 14 August 1975. The first option was total passive protection for all occupant positions in all crash modes. The second option was passive protection for front seat occupants with a lap belt at each seating position and a warning system. Later, in February 1972, the ignition interlock system was permitted as a third option, as described later.

In this period, the NHTSA seemed to take a strategy to set a tight deadline, to push the automobile manufacturers as far as possible, and then to defer as the difficulty to meet the deadline materializes. The manufacturers criticized NHTSA saying its proposals for occupant protection were not well organized and the comment period is too short.

Chrysler vs. DOT

In response to the NHTSA's March 1971 ruling, Chrysler Corporation, followed by several other manufacturers (but not General Motors), challenged the regulation in the U.S. Court of Appeals for the Sixth Circuit. Chrysler argued that the regulation violates the objectivity and practicability criteria of the Safety Act, and that it also violates the Administrative Procedure Act's requirement that promulgation of a new standard not be an "arbitrary, capricious, and abuse of discretion." The verdict was reached on December 1972. The court ruled in favor of NHTSA that the agency was empowered to issue standards requiring improvements in existing technology; and that its action were rational rather than

arbitrary and haphazard. However, the court agreed with the plaintiff that the test procedures and test dummy specified in the standard did not meet the required criterion of objectivity. Consequently, the final ruling remanded the proposed standard to NHTSA with instruction to rewrite them to ensure more objectivity.

1972-1976

Interlock Controversy

In February 1972, the ignition interlock system was permitted as a third option for vehicles manufactured between 15 August 1973 and 14 August 1975. This system consists of an electric linkage between seat belts and an ignition switch with simple sensors beneath the front seat; it prevents a car from being started with unbelted front seat occupants. After appearing in automobiles in the fall of 1973, the ignition interlock was severely criticized by the motoring public because of its intrusiveness. The Insurance Institute for Highway Safety quoted an “in-house” NHTSA bulletin as follows (NTSB, 1979b):

“Over 98% of the persons writing to NHTSA about the ignition interlock system oppose it ... Major reasons cited are that the interlock is an infringement on individual rights, that it is cumbersome and inconvenient and that it will be an added burden to the car’s electronic system.”

As a result, Congress repealed the standard in October 1974 by allowing consumers to choose either ignition interlocks or a warning system (a buzzer and lights).

In addition, the new law required that NHTSA notify Congress of any proposed occupant restraint standard, and that the concurrent resolution of Congress could disapprove the amendment within the next 60 days.

This interlock fiasco is referred to as a public relation failure for NHTSA which did much to create a negative image of the agency. (Irwin, 1985) According to a congressman, however, the permission of ignition interlock as an alternative to comply with the passive restraint mandate was forced on NHTSA, over its objection, by the White House after the presidents of the two of the major auto manufacturers visited the President of the United States. NHTSA may have been blamed for a decision made by others.

GM's Unsuccessful Marketing of Air Bags

General Motors intended to sell 100,000 air bag equipped cars during the 1974-1976 model years. In 1974, GM began offering the air bags as an option on full-size Buick, Cadillac and Oldsmobile cars. The price for all the three front passengers varied from \$181 to \$300. However, GM only sold about 10,000 cars with air bags. The reasons for the failure, according a report prepared by a consultant for NHTSA, were lack of dealer commitment, unanticipated consumer concerns about the air bag's safety, and availability on large cars instead of small cars. (NHTSA, 1984) The program terminated in 1976. After this, none entered into production until Mercedes Benz offered air bags as a supplement to the driver's three point manual belt beginning with the 1984 model year.

1976-1981

Secretary Coleman and Adams

William Coleman, shortly after assuming office as a Transportation Secretary in 1975 under President Ford, began reviewing the issue. In December 1976, one month before giving way to his successor under the Carter administration, Coleman decided to call upon the manufacturers to join the Federal Government in conducting a large-scale demonstration program to exhibit the effectiveness of passive restraints. The voluntary demonstration program would involve 500,000 new cars of GM, Ford and Mercedes Benz during model year 1979 and 1980.

However, Coleman's successor, Brock Adams, shortly overturned this plan explaining that the public acceptance of passive restraints is not one of the statutory criteria and that the demonstration program would further delay the implementation of the regulation. His decision in June 1977 required:

provision of passive restraint protection in passenger cars with wheelbase greater than 114 inches manufactured on and after September 1, 1981, in passenger cars with wheelbase greater than 100 on and after September 1, 1982, and all passenger cars manufactured on and after September 1, 1983. (Federal Register 34289)

Secretary Adam's decision to mandate air bags was under the Carter administration's determination in its first few months of office to appear decisive and firm in its stated purposes of pushing ahead new consumer protection legislation. (Irwin, 1985). The administration's pro-safety intent was also reflected in the appointment of Joan Claybrook, a determined advocate of air bags, as the head of NHTSA.

Immediately after the Adams decision, a resolution to overturn the decision, based on the revision of Safety Act in 1974, was introduced in the Congress. Congressional hearings were held in September 1977 on various issues relating to the air bag such as testing experience and effectiveness estimates, liability, and costs. After the hearings, Congress rejected the legislation to overturn the passive restraint rule, thereby affirming Adam's decision.

Pacific Legal Foundation/ Ralph Nader vs. DOT

In response to the Secretary Adams decision, the Pacific Legal Foundation (PLF), a conservative public interest group, filed a suit against DOT in September 1977 requesting the Adams' rule be set aside. On the contrary, Ralph Nader and his group Public Citizen filed another suit in January 1978 requesting that the implementation of the regulation should be hastened. In February 1979, the court dismissed the arguments of both petitioners and simply affirmed the Adams ruling.

Shifts in Compliance Strategy

Though the Adams rule survived the congressional and judicial challenge, air bags were not emerging in the market as expected. By late 1978, the Iranian oil crisis and soaring gasoline prices were threatening the survival of the large-car market in the United States. Auto manufacturers were shifting their compliance plan from air bags to automatic seat belts. Major air bag manufacturers such as Allied Chemical and Eaton dropped out from the air bag business in late 1978.

In order for the air bags rather than automatic belts to be installed, Congressman Warner introduced a bill in July 1980 that would require air bags on at least one line of cars for each large manufacturer with a delay of the standard from 1982 to 1983 and reversal of the compliance schedule so that small cars would be covered before large cars. This bill eventually failed to pass in December 1980, one month before the Reagan administration began.

1981-1984

Rescission

In January 1981, Ronald Reagan entered the White House with a promise to provide “regulatory relief” to the U.S. industry which was plagued with recession due in large part to the two oil crises in 1973 and 1979. In November 1981 the NHTSA administrator Raymond Peck announced his decision to rescind the passive restraint regulation. His reasoning was that (1) almost all cars subject to the standard, according to NHTSA’s prediction, would be equipped with automatic seat belts rather than air bags, (2) automatic belts can be easily disconnected, and are not likely to result in substantial increases in belt-wearing rate, and (3) therefore, the public would protest a regulation that is expensive but offers little safety benefits.

Supreme Court Decision

In response to the NHTSA’s rescission, State Farm Insurance Company filed a suit in March 1982 to the Court of Appeals in the District

of Columbia challenging NHTSA's rescission of the passive restraint standard. In June 1982 the court rejected the NHTSA's decision, arguing that NHTSA acted "arbitrary and capriciously" in rescinding the standard.

NHTSA made further appeal to the Supreme Court in September 1982 insisting on its right to revoke a safety standard when changed circumstances might nullify the safety benefit. The decision of the Supreme Court in June 1983 essentially supported the Court of Appeals and found that NHTSA's decision to rescind the passive restraint standard was "arbitrary and capricious," arguing that possible disconnection of automatic belts by the motorists was not evidence against the air bags, and thus the agency should consider mandating the air bags themselves. The court thereby returned the issue to the NHTSA.

The defeat of NHTSA can be attributed to Administrator Peck's poor reasoning for the rescission. As John D. Graham mentions, "If Peck had challenged both automatic belts and air bags as being economically unreasonable, he might have fared better in the Burger Court." (Graham, 1989)

Dole's Plan

After the Supreme Court verdict, Elizabeth Dole, who was appointed in 1983 as the second Secretary of Transportation in the Reagan administration, presented three alternatives in October 1983:

(1) reinstatement of the passive restraint standard; (2) Amendment of the standard to ban permanently detachable seat belts or to require air bags; and (3) rescission of the standard again. Dole formed a small team of policy

advisors and brainstormed the issue. By the spring of 1984, they came up with a plan that called for reinstatement of the standard unless enough states passed compulsory belt use laws by 1989.

On July 11 Secretary Dole announced a new final rule requiring passive restraints to be installed in 10 percent of 1987 models, 25 percent of 1988 models, 40 percent of 1989 models, and 100 percent of 1990 and later models. The plan also included a rescission provision designed to encourage states to adopt mandatory seat belt use laws. If states covering two-thirds of the nation's population enacted mandatory seat belt use laws before April 1, 1989, the requirement for passive restraint would be removed.

Dole's ruling, as we will see later, would eventually survive various challenges, and would put an end to the long controversy over the passive restraint regulation. Her key insight was to offer powerful interest groups something they desired and thereby reduce the vulnerability of her plan: safety advocacy groups and insurance industry got a passive restraint regulation, and automobile manufacturers got a rescission provision.

(Graham, 1989)

1984-1989

Ford's Petition

In August 1984 Ford petitioned NHTSA to count cars with driver-side air bag only as one credit toward the automatic restraint quotas. This petition was granted in the fall of 1984, and it gave incentive to manufacturers to install air bags because it meant that a driver-side air bag is equivalent to two automatic seat belts in terms of credit toward

compliance. In another petition in June 1986, Ford requested NHTSA to revise the passive restraint rule so that supplemental driver-side air bags and passenger-side manual belts would continue to satisfy the standard for 1990 and later models. In March 1987 NHTSA adopted Ford's petition, and delayed full-front passive restraint until model year 1994 for those cars in which air bags were installed on the driver-side.

The underlying motivation for these petitions is the determination of Ford to market air bags rather than automatic seat belts. Due to unresolved technical problems, passenger-side air bags would not be ready until the beginning of 1990s. Though Ford could have chosen to install automatic seat belts in both front seats, the company opted to go with driver-side air bags, and the petition was meant to devote scarce resource for development to air bags until passenger-side air bags will be ready. (Graham, 1989) This move is viewed as the second turning point of the U.S. auto industry since they turned from favoring to opposing against the air bag in the early 1970s.

Rescission Provision Terminates

After Secretary Dole's decision in 1984, automobile manufacturers began mobilizing safety belt promotion campaign to encourage states to adopt mandatory belt use laws with massive \$15 million funds. New York had enacted the first belt use laws just before Dole's decision, and other states began to follow suit. Due to the fear that automatic restraint standard might be rescinded, some states which wanted both the air bag standard and the seat belt laws tried to pass weak laws that would not

qualify for the federal requirement of belt laws. (minimum penalty for non-wearing, etc.) Not enough states enacted mandatory seat belts use laws to cover two thirds of the U.S. population by April 1, 1989, and the rescission provision relating to belt use laws expired.

1989-Present

Extension to Light Trucks

In March 1991, NHTSA issued a rule that requires "light truck" including minivans, small pickups, and sport utility vehicles be equipped with automatic restraint on both the driver and front passenger sides on the following schedule: 20 percent of the vehicles manufactured after September 1, 1994; 50 percent of those manufactured after September 1, 1995; 90 percent of those manufactured after September 1, 1996; and 100 percent after September 1, 1997.

Congressional Action to Mandate Air Bags

In December 1991, the Senate incorporated the NHTSA reauthorization bill into the Intermodal Surface Transportation Efficiency Act (ISTEA). The bill specified numerous highway and auto safety measures including amendments to the FMVSS 208. The Act required NHTSA to issue a final rule by September 1, 1993 requiring full front-seat air bags as follows:

- 95 percent of passenger cars manufactured after September 1, 1996
- 100 percent of passenger cars manufactured after September 1, 1997
- 80 percent of light trucks manufactured after September 1, 1997
- 100 percent of light trucks manufactured after September 1, 1998

The Senate's initiative was based on their feeling that NHTSA should be more aggressive, and was achieved due to the efforts of at least five very determined Senators, backed by a coalition of consumer advocates and insurance companies, over the opposition of House Energy and Commerce Committee which had insisted on a provision that nothing in that Act (ISTEA) could supersede NHTSA authority under the National Traffic and Motor Vehicle Safety Act of 1966. (Reed, 1992)

Where Are We Today?

In the United States, the air bag is a common feature of today's automobile. In 1994, car installed with air bag system represented about 85 percent of the new cars sold (35 percent is with driver air bags, and 49 percent is with dual air bags). (NHTSA, 1996) As of writing of this thesis the beginning of the phased-in requirement for dual front air bags for passenger cars is several months away. But most cars produced for the U.S. market have air bags rather than automatic seat belts. As the front air bags are virtually standard today, automakers are beginning to market additional features such as side air bags. From the start of the development of air bags, it took nearly forty years for them to be mandated in automobiles in the United States.

Summary of Chapter 2

We have reviewed the long and complicated history of automatic restraint regulation. As we have seen, although the authority to promulgate automobile safety regulation is delegated to the administrative agency (NHTSA), the agency was not able to make decision independently, but it was exposed to various pressure from outside interest groups which is affected by the regulation. Under this political pressure, the agency's series of decision was not necessarily consistent, and thus it is difficult to explain why the regulation evolved as it did, other than to say that it was the result of compromise among various conflicting interests.

In chapter 3, we will keep our distance from political environment and discuss the theoretical framework for judging the appropriateness of the safety regulation.

Chapter 3

Framework for Safety Regulations

In this chapter, we intend to construct a framework to assess the appropriateness of safety regulations on motor vehicle occupant restraints. The framework can be based on different perspectives: those of economists, public health professionals, etc. These different perspectives share some concepts in common while differing on other concepts. In this thesis, the discussion is based primarily on an economic perspective, but the limitation of that viewpoint also addressed.

Apart from the distinction of perspectives shared in different professional communities, it is useful to introduce the distinction of perspectives between that of the individual and the society. These two perspectives are both important in the consideration of the safety of automobiles, because, unlike public transportation systems where users have little input in its safety, private automobiles are owned, maintained, and, most important, operated by individual users; at the same time the use of automobiles can not be isolated from various societal contexts.

We start with an economic perspective to describe the relation between the individual and society regarding the use of occupant restraints, and then introduce a perspective of the public health professionals.

The Individual Perspective

The individual perspective concerns how the occupant recognizes the risk of accidents and behaves to cope with the risk imposed upon him. In

the absence of any regulations, he can, for example, purchase a car equipped with air bags (if available) or he can wear seat belts, or else he can do both or do neither. When choosing whether or not to wear a seat belt, the occupant, according to economic theory, is supposed to make a valuation of cost and benefit of his/her decision: the cost is the inconvenience or discomfort of wearing belts, and the benefit is the reduction in the "risk" of an accident (i.e. the probability to have an accident times the consequence -- -- fatality or injury -- of that accident).

When we observe that a substantial proportion of occupants choose not to wear seat belts which are readily available in most vehicles, there can be different explanations for the choice made by those individuals. One explanation is that the occupant does not correctly anticipate the chance of getting injured or the efficacy of seat belts in reducing the risk of injury or fatality. Researchers report that lay people tend to underestimate the risk of getting injured. (Arnould, 1981) In this case, an irrational choice is being made, and there is a possibility for correction, for instance, by providing proper information or mandating seat belt use.

Another explanation is that the occupants perceives the risk correctly, but the cost of wearing belts such as inconvenience and discomfort outweighs the benefit of the reduction of risk. In this case the choice not to wear a seat belt is a rational one in that the resource allocation for the occupant is efficient in an economic sense. Then, for the occupants to make a decision to wear a seat belt, the inconvenience or discomfort must be

reduced. To mandate seat belt use without that reduction would lead to the “over-consumption” of safety, and would be suboptimal for the individual.¹

As for the automatic restraints such as air bags, a similar personal valuation of cost and benefits is assumed to take place. This decision is made when purchasing an automobile. Unlike seat belts which are readily available for use, air bags have other problems: availability and affordability. Even though drivers are assumed to be well informed of the risk of injury and the effectiveness of air bags in mitigating the risk, they can not choose to buy air bags if they are not available in automobiles that they intend to purchase or prohibitively expensive. This issue will be discussed later.

Risk Compensation and the Driver Behavior

Throughout this thesis we assume that the occupant restraints can change the consequence of an accident once it occurs, but will not change the probability of the occurrence of accidents. However, this assumption may be subject of criticism.

Occupant protection measures, be it seat belt use or passive restraints, generally give drivers a sense of security. Then the drivers may respond by taking more risks in driving, compensating for the increase in protection. Put more simply, protecting car occupants from the consequence

¹ Mannering et al. calculated the cost and benefit of wearing seat belts, based on a survey result showing that time to fasten seat belt is the dominant factor affecting people's decision on whether to wear seat belts. They found that the total cost of seat belt use in terms of time required to fasten belts over the duration of vehicle ownership is \$6,442, while the benefit from seat belt use in terms of reduction of risk over the life of vehicle ownership is \$5,249. (Mannering et al., 1987)

of bad driving may encourage bad driving. This is called the risk compensation hypothesis, and was argued by John Adams in the controversy in the British parliament over mandatory seat belt use law in the late 1970s. (Adams, 1982) A similar argument was made by Sam Peltzman to explain the pattern of road fatality in the United States after the introduction of the first federal safety standards. (Peltzman, 1975)² Their arguments are backed by statistical evidence of road safety records in several countries with and without seat belt use laws, or by the comparison of statistical trend before and after the safety standard was adopted. The validity of such statistical evidence has been questioned by other researchers who doubt the hypothesis (Graham, 1983), and thus far, a conclusion has not been reached.

If we take an economic perspective which assumes a risk/benefit trade-off, then accepting the existence of risk compensation is quite natural, because, if the subjective risk level changes as a result of safety measures, the balance between the risk and other benefit should change one way or another. Then, what matters in this argument is not so much whether the compensation exists as to what extent the compensation could dampen the effect of safety measure. Also, if we assume that risk compensation exists to an extent which substantially increases risk taking, we should also worry about the external effect, i.e. the risk that such dangerous driving imposes on adjacent traffic and pedestrians, as well as the risk of the driver himself.

² Both of them argued that "forcing" drivers to receive protection more than they would voluntarily choose would lead to more risk taking in driving. But more generally, safety measure does not have to be "forced" to induce more risk taking: safety measures chosen voluntarily can also induce more risk taking.

However, due to the lack of convincing evidence and to the practical difficulty in obtaining such evidence, the hypothesis has not been taken into account in the regulatory analysis. In the final regulatory impact analysis of automatic restraint in 1984, NHTSA concluded that “In summary, the Department finds no data to convince that the risk compensation theory applies in the case of mandatory use laws, or automatic restraints. Nor has it found any data to help quantify this effect.” (NHTSA, 1984)

To minimize the extent of supposed risk compensation, safety measures that address motivational aspects such as financial incentives, law enforcement or education for safer driving should accompany occupant protection measures. Also, safety measures that reduce the subjective level of danger more than the objective level may induce risk compensation that can have an adverse effect. (Hale et al., 1989) According to this view, advertisements of air bags as panacea which can give drivers false sense of security should be regarded with caution.

Societal Perspective

From the perspective of society, what matters in road traffic accidents is the aggregated consequence of accidents within the society, rather than who in the society loses. Likewise, when we consider countermeasures to curtail the risk of accident, the focus tends to be on how much we can benefit as a whole society and not on who benefits. This simple aggregation seems to be based on the assumption that road accidents can happen to anyone in the society, and not to specific individuals or to specific groups of people.

The notion that road traffic accidents can happen to anyone is convenient for the government when it designs a countermeasure and evaluates its impact. The automobile safety regulation, which can be viewed as a partial collectivization of private decision on vehicle design, is based on this perspective. We examine the rationale for this perspective below.

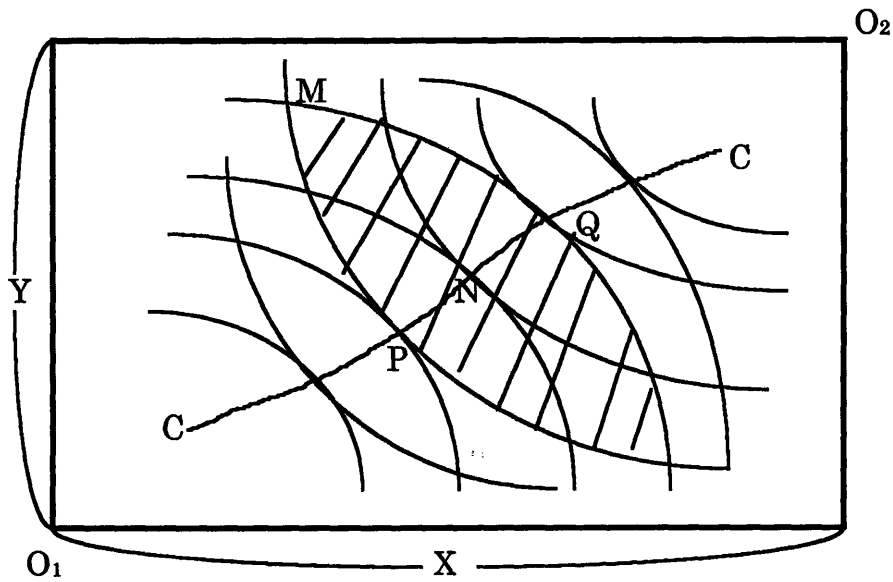
Pareto Optimal

Welfare economics intends to define how the preference and well-being of individuals relates to social welfare or desirability. Welfare economics has only one objectively valid statement of desirability: if no individual considers himself have been made worse off and at least one considers himself better off, the overall change should be considered desirable. Another desirable change may still be possible. If none is, the final state is defined to be "Pareto-optimal" or "efficient."

The Pareto-optimal state is illustrated using the Edgeworth Box. (Figure 3-1) Let us think of a society consisting of two individuals and two goods. The amount of each good is fixed (X and Y), and distributed between Individual 1 and 2. The distribution for Individual 1 and 2 is measured from origin O_1 and O_2 , respectively. All the tangential points between iso-utility curves for Individual 1 and 2 consist the contract curve. If the initial state is M, then both two individuals can achieve higher utility by moving to some point in the shaded area bartering the two goods. If the distribution reaches a point on the contract curve, say N, then further move can not be done without reducing utility of at least one of the two individuals. Thus, the move from the original state to a point on the contract curve inside the

two iso-utility curves that involve the original state (i.e. contract curve between P and Q), is an improvement of social welfare. In addition, distribution represented by a point on the contract curve is Pareto-optimal. (Fujii, 1985)

Figure 3-1 Edgeworth Box



Economic theory also states that market systems satisfying three conditions (perfect information, perfect competition, and no externality) will at least achieve one of the Pareto-optimal states depending on the initial distribution of assets. When the three conditions are not met (i.e. market failure exists), it could warrant some intervention so that the market can reach the state that would result from a perfect market given the current distribution of assets.

Discussion of Market Failure

Economic theory states the condition where individual decision gives the optimal solution for the society as well: (1) that the individuals have sufficient information about their choice, (2) that the individual is provided with a sufficient amount of choice from suppliers' competition, and (3) that there are no externalities. If these conditions are not met, or in other terms, if market failure exists, the individual's decision does not necessarily lead to the optimal state from societal standpoint. From the viewpoint of this thesis, in the market for occupant restraints, we can find symptoms of market failure.

First, as mentioned above, there is a suspicion that the drivers are not well informed about the risk of accidents and the effectiveness of restraints such as seat belts and air bags. On surveys, respondents systematically underestimate their risk of having an automobile accident, and also the efficacy of seat belts in the case of an accident.

Arnould and Grabowski sites the result of a 1979 study by Teknekron Research Corporation on the public perceptions of highway safety that involved 1500 licensed drivers. The respondents were asked how likely do they think it is that they will be involved in an automobile accident of any kind in the next year, either one caused by their own or someone else. They were given five choices ranging from one in five to one in 100. "Only 23% chose an alternative with odds equal to or less than the societal wide average (which was one in ten), while odds the majority selected was one in 100 or greater!" (Arnould et al., 1981)

Second, the limited competition in the automobile market is another factor of market failure. Though there are several automobile manufacturers and the competition among them is rather fierce, the market share of top companies is substantial, and this could have narrowed the consumer choice in the case of automatic restraint: consumers who were willing to pay for air bags did not have the option available until the mid 1980s (except for a few cases such as GM's provision of air bags as an option in some luxury models as described in chapter 2.)

Third, the externality argument is widely employed to support governmental intervention: although the non-use of restraint does not harm others physically, it impose various economic burden to others. Cost component include productivity losses, medical costs, rehabilitation costs, travel delay, legal and court costs, emergency service costs, insurance administration costs, premature funeral costs, and costs to employers. These costs are not solely defrayed by those who are involved in the accident but passed on to the society in the form of increased insurance premium, health care costs and taxes.

This argument is prevalent in the discussion of mandatory seat belt or motorcycle helmet use. If the medical cost increase due to non-use of restraint can be passed on to the society and thus not included in the utility of the occupant, then his decision on whether or not to use a restraint is not optimal for the society though it might be optimal for him.

Though figuring out who actually pays the accident cost is no easy task, there is a report which tracked down the source of medical payment. As required by the Intermodal Surface transportation Efficiency Act

(ISTEA) of 1991, the NHTSA studied the benefit of safety belt use and motorcycle helmet use by constructing a database system called Crash Outcome Data Evaluation System (CODES) which links accident data and medical treatment data. In a report to the Congress in 1996 NHTSA found that:

“the average inpatient charge for unbelted passenger vehicle drivers admitted to an inpatient facility as a result of a crash injury was more than 55 percent greater than the average charge for those that were belted, \$13,937 and \$9,004 respectively. If, in the CODES states, all unbelted passenger vehicle drivers had been wearing safety belts, it is estimated that inpatient charges would have been reduced by approximately \$68 million and actual inpatient costs reduced by \$47 million. Private insurance accounted for 69 percent of the inpatient charges compared to 16 percent for public and 15 percent for other sources. In all cases, the average inpatient charge was greater for drivers who were unbelted.”

Table 3-1 shows average and total inpatient charges by source of payment and safety belt use. Since most severely injured people who become medically needy can apply for Medicaid as a result of their injuries, higher charges to public payers does not necessarily indicate the difference between the inpatient cost of those who are privately insured and those who are not. Rather, we should note the potential magnitude of cost imposed on society by those who do not use seat belts and the possibility to save such cost by making them use seat belts or other restraint.

Table 3-1 Average and Total Inpatient Charges by Source of Payment and Safety Belt Use for Crash-Involved Drivers in the CODES States **

Source of Payment	Average Inpatient Charge			Total Inpatient Charges
	Belt Used	Belt Not Used	Difference	
Public (*1)	\$13,322	\$18,922	\$5,600	\$26,498,675
Private Insurance (*2)	\$8,581	\$14,058	\$5,477	\$113,156,421
Other (*3)	\$9,180	\$10,534	\$2,354	\$24,788,922

*1 Includes all charges to government funded sources including Medicaid, Medicare, etc.

*2 Private insurance companies including worker's compensation.

*3 Usually self payment.

** Hawaii, Maine, Missouri, New York, Pennsylvania, Utah, and Wisconsin.

Source: NHTSA, 1996b

Is the externality internalized for those inpatients who are paid by private insurers? Not necessarily. Though the amount of externality should be smaller compared to those who are paid by public money since the former inpatients have paid insurance premiums, the externality is not completely internalized because the insurance premiums are not adequately differentiated for the restraint users and non-users presumably due to various practical difficulties in effectively monitoring user behavior, which will be discussed later.³

In any case, we should note that the non-use of seat belts does lead to higher medical costs, and that such costs are not entirely covered by the belt

³ Some insurance companies offer premium discount to those who pledge to wear a belt, or policies with double indemnity for cases where the insured person is killed or seriously injured while wearing a belt.

non-users: thus the externality argument is relevant. To quantify the magnitude of externality, we first assume that the average severity of accidents (i.e. delta-v and the direction of impact, etc.) which occur to belt users and non-users are the same: this means that if the current non-users wear belts, the average inpatient charge of non-users will decrease down to the average inpatient charge of current belt users. Second, for those inpatients who are paid by public sources and private insurers, we assume that the inpatients do not bear the cost themselves. Though the inpatients who are paid by private insurers had paid the premiums themselves, the additional medical cost for not wearing belts are not adequately reflected in the premiums as mentioned above. Therefore, such additional cost can be seen as being paid by the society as a whole. Third, the belt use rate of inpatients is assumed to be 50 percent.

Based on these assumptions and the data in Table 3-1, we can calculate the proportion of additional medical cost imposed by the belt non-users to the society is:

$$[5600 \times (26/113) + 5477] / [(13322 + 18922) \times (26/113) + (8581 + 14058)] = 0.2$$

Thus, about 20 percent of the medical cost are due to the non-use of seat belts which the non-users do not bear by themselves but impose on the whole society in terms of taxes and insurance premium.

The total medical cost due to road traffic accident is estimated as \$14 billion. (NHTSA, 1990) Though the breakdown of this cost into vehicle occupants and non-motorists is not known, if we assume the ratio to be 10:1, (from the fact that the ratio of occupant fatalities and nonmotorist fatalities is 5:1, and the ratio of occupant injuries and nonmotorist injuries

is 15:1 (NHTSA, 1994)), the medical cost for treating vehicle occupants is estimated as \$13 billion. Consequently, 20 percent of \$13 billion or \$2.6 billion is the external cost for seat belt non-use. This means every year, every U.S. citizen bears \$10 for medical care for those who do not use seat belts.

What one can infer from this situation is that we should try to internalize the external cost imposed to society by 'irresponsible' behavior (i.e. non-use of seat belts). Let us limit our discussion to medical cost for simplicity. Theoretically, this can be done by eliminating all public and private health insurance system, and make everyone pay for his/her health care. Of course, this is too extreme, because some injuries are unavoidable even if one exercise a due care.

Secondly, we can think of a insurance system which pay for the medical cost only for an injury which is unavoidable even if the driver exercise appropriate care. In the case of seat belt, the health insurance system will pay for the care of unbelted and injured occupants up to the amount which would be necessary to care for a belted occupant in the same situation. The remaining portion of the cost must be paid by the unbelted occupants. However, this kind of ex post adjustment leads to a reality that many unbelted victims can not bear the remaining cost by themselves. And the society does not seem likely to be so harsh as to dismiss those victims.

Third and seemingly the most practical idea is to spread the additional medical cost due to the non-use of seat belt not to the whole society but only to those who do not use belts. This can theoretically be done by differentiating the insurance premium between belt users and non-users.

Practically, there are numbers of problems: (1) how to appropriately monitor occupants' belt-using behavior, and (2) how to deal with those who are found to be unbelted in a accident, although he had paid lower premiums for belt users. Though the latter problem can be dealt with higher deductibles, the former problems remains, and this seems to be the major barrier against adopting the differentiated premiums.

Having discussed the difficulty of internalizing the external cost of belt non-use, we can conclude that one of the remaining countermeasures to this problem would be to force people to use seat belts by enacting a belt use laws. This will be discussed in the next section.

Still another issue is what would happen to the situation if air bags are added. Since the data in Table 3-1 does not distinguish whether air bags were deployed or not, we can not know the quantitative impact of air bags on the additional cost of belt non-use. Given the effectiveness of air bags, it is clear that the total medical cost and the additional medical cost will decrease due to air bags. However, another complication arises: this is the difference in the effectiveness of air bags for belt users and non-users, which will be discussed later.

Governmental Fiat and the Relaxation of Pareto Optimal Criterion

The existence of market failure can give rationale for some forms of government intervention. The economists' first choice for such intervention are typically measures which attack elements of market failure such as consumer information program, antitrust actions, and insurance premiums that reflects the correct risk of each driver.

When these measures are not effective due to one reason or another, as explained in the former section regarding the case of differentiated premiums for belt users and non-users, the government can consider more coercive intervention such as mandatory air bag installment or mandatory seat belt usage. However, since such governmental fiat does not directly address the three conditions of market failure, we can not know whether the regulation will lead to or approach the optimal state in the social perspective (Pareto optimal state), or even in the individual perspective.

Therefore, we should think of a way to derive a workable social desirability criterion from the Pareto optimal statement. A widely used method is to relax the aforementioned Pareto optimal statement, and to accept as desirable any change in which the individuals who are made so much better off that they would be able to compensate the individuals who are made worse off and still come out ahead on the change. This relaxed Pareto-optimal criterion is called the “Kaldor-Hicks test” and is the theoretical foundation of the cost-benefit analysis which is discussed below.

Cost-Benefit Analysis

One way to assess whether an effort to improve safety is worthwhile is the cost-benefit analysis. This method can be applied both from the individual and societal perspectives.

From an individual’s perspective, the application is quite straightforward: as mentioned earlier, the individual weighs the cost of effort (in this case, wearing seat belts or buying air bags) and the resulting benefit (reduction in the risk of injury, where risk is the probability of an

accident times the consequence). If the cost outweighs benefit in one's own utility function, he simply does not undertake the effort. This weighing is supposed to be taking place inside each individual's mind, and it is not necessary to reveal the valuation. We should note here that when individuals do not have to pay the full cost of injury care due to various externality, then the personal valuation of benefit of reduced risk of injury will be less, because the individual will take into account only the cost and benefit that would affect his own utility.

From a society's perspective, cost-benefit analysis must aggregate the cost and benefit of each individual. As mentioned earlier, for this method to be a measure of the social desirability, we must assume that those who will be better off can compensate those who will be worse off.

Criticism for Social Cost-Benefit Analysis

In reality, it is difficult for the above compensation to take place because of the difficulty in setting up the mechanism for proper compensation. This point -- that social cost-benefit analysis in reality neglects distributional or equity issues -- is the subject of criticism.

Another criticism of social cost benefit analysis is that it tends to ignore those benefits and costs which are difficult to quantify. Unlike individual cost benefit analysis, social cost benefit analysis needs to explicitly quantify the cost and benefit for each individual which depend upon his utility function.

In the case of occupant protection, the true valuation of benefit theoretically requires each individual's accident risk spectrum (probability

density function for every consequence), his valuation of each consequence, and the information on how the proposed countermeasure would mitigate the consequence (i.e. how the accident spectrum of probability-consequence function will be changed by the countermeasure). In practice, this quantification for each individual is never possible. Therefore, we have to ignore the difference of each individual's valuation of fatality avoidance, and substitute it with a uniform figure known as "value of life." Many researchers have been trying to find appropriate ways to determine this value, but it is far from being resolved in a satisfactory way.

The valuation of the cost of a countermeasure is also difficult. When considering mandatory seat belt use law, the incremental cost does not seem to be much, given that the seat belt is already equipped in almost all automobiles. However, the inconvenience and discomfort of wearing belts can be quite large for those who refuse buckling. The social cost-benefit analysis tends to ignore these personal preferences altogether or substitute by arbitrary figures.

Cost Effectiveness

Cost benefit analysis of safety intervention requires valuation of fatality and injury prevention in monetary terms, which is ethically controversial and practically difficult. To avoid this problem, the cost effectiveness ratio is occasionally used in evaluating programs. The cost effectiveness ratio uses the benefit measured by their physical quantity rather than in monetary terms. (de Neufville, 1990)

$$\text{Cost-Effectiveness} = (\text{Units of Benefit}) / \text{Cost}$$

For example, safety programs are evaluated in terms of “lives saved from accident per thousand of dollars.” Or one can use the inverse of this such as “dollars required to save one life from accident.” If very good information is available, one can use more refined measure of cost per quality adjusted life year (QALY) saved, thus taking into account both the number of person-years gained and their quality. (Zeckhauser et al., 1990)

A major disadvantage of the cost effectiveness is that it does not define any minimum standard. Since it does not place effectiveness on the same scale as cost, one can not know whether the improvements offered by a project are worthwhile or not.

Cost effectiveness analysis is useful in comparing different projects having the same objective. However, one should be cautious about the “ratio” nature of its concept when comparing projects of different sizes. We can compare, in a strict sense, relative desirability of two projects as long as they have either approximately the same amount of costs or approximately the same amount of benefits.

Public Health Perspective

The public health perspective on traffic safety was a major driving force that led to the National Traffic and Motor Vehicle Safety Act of 1966 and subsequent automatic restraint regulation. It is not necessarily mutually exclusive from an economic perspective, but it is more focused on the benefits rather than the cost of regulation. So, cost effectiveness analysis rather than cost benefit analysis suits this perspective. Also, as the term “public” correctly suggests, it is more focused on societal benefit rather

than individual benefit, whereas an economist begins with an individual and then extends to the society. Moreover, public health professionals tend to rely less on the “rationality” of individuals, and tend to prefer countermeasures such as passive restraints that do not rely on individual behavior. Below, we review some of the arguments from the public health perspective.

Safety as a Public Good

The economic externality argument described above, to some observers, can be a kind of guise for some other desire to be fulfilled as Kenneth Warner wrote:

“Put simply, it is a concern with the aggregate death and disability burden of avoidable injuries, a conviction that such avoidable damage is, simply, socially untenable. This attitude likely arises from a number of sources, including general concern for the public health and welfare and compassion for known victims of accidents and hence the desire to help prevent others from realizing the same fate.”

Warner admits that in an economically and politically conservative environment, the counterargument of paternalism is strong. But he argues that, “It is quite reasonable, however, to describe the motivation in economic terms, relying on the concepts of externality and public goods.” Regarding the former, he contends that both the individual tragedies and the collective toll of automobile accident injuries impose an emotional burden on other members of society, not limited to the family and friends of victims. From the public good concept, the aggregate toll of motor vehicle accident injuries represents a “public bad,” and the sense that reducing the total would

represent a public good, one that is achieved through individual or societal decisions regarding the use of restraints. (Warner, 1987)

Change in Personal Values in the Course of a Lifetime

There is another argument which might build a bridge between the public health perspective and the economic perspective. With regard to the public policy on seat belt non-use, John D. Graham wrote:

“Moreover, personal utility functions may change over a lifetime, further complicating the matter. For example, I believe that demands for safety generally become stronger as people mature. The radically different accident experience of young adults compared to middle-aged ones suggests that demands for safety changes systematically over the life span. If this is so, does not society have an obligation to protect or restrain individuals whose preference are likely to change in a predictable fashion as they mature? Imagine the to-be-crippled 40-year old pleading to himself at age 20 to please wear his safety belt. Whose preference should be respected with regard to “individual freedom” -- the current or future person? Alternatively, one can view the refusal of a person to wear safety belts as an involuntary imposition of health damage on a “different person” (i.e. the same person 20 years older). It is widely accepted that government has an obligation to prevent one citizen from imposing (without compensation) injury risk on another citizen who does not wish to incur that risk.” (Graham, 1983)

This view clearly indicates the limit of economic perspective towards life and limb which does not take into account the possible change of one's utility function in the course of a lifetime, while injury can have lifelong and sometimes irreversible effect.

Distributional Effects of Air Bag Regulation: Belt Users vs. Non-Users

The social cost-benefit analysis, due to its aggregating nature, does not take into account the distributional effect of safety regulation, i.e. the uneven impacts of the regulation to various subgroups of the society. Therefore, the issue tends to become a subject of political deliberation and judgment by decision makers who represent various constituencies. Though this may be an ideal way of decision making in a democratic society, it seems still useful to clarify the kind of distributional effect behind political judgment, because this factor is closely related to the extent to which the social cost-benefit analysis can be useful as a decision making tool.

We have already discussed part of the various distributional effects of automatic restraint regulation in Chapter 2 where each actor's view toward the regulation was introduced. For example, the automobile manufacturers thought they would be worse off because the demand for new automobile would be reduced as a result of price hike due to automatic restraint or because product liability lawsuits would intolerably increase. In this chapter, we will discuss another kind of distributional effect which did not receive much attention in the controversy: the uneven impact for belt users versus belt non-users.

For those drivers who currently wear seat belts, passive restraint offers relatively small benefit compared to those who do not wear belts. In the case of the automatic belt, the device offers virtually no benefit to current manual belt wearers other than the convenience of not having to buckle up by themselves. In the case of air bags, the device gives some

incremental benefit of injury mitigation to belt wearers, whereas it gives non-wearers larger benefit.

In 1984, NHTSA estimated the effectiveness of various occupant restraints as shown in Table 3-2. Percentage effectiveness means that if all the occupants wear, say, manual lap/shoulder belts, then 40 to 50 percent of those occupants would survive otherwise fatal accidents. (Conversely, 50 to 60 percent of occupant death is not escapable even if manual lap/shoulder belts are used.)

Table 3-2 NHTSA's Estimate of Percent Effectiveness of Occupant Restraints

	Manual Lap/Shoulder Belt	Air Bag Alone	Air Bag with Lap/Shoulder Belt
Fatalities	40-50%	20-40%	45-55%
AIS 2-5 Injuries	45-55%	25-45%	50-60%
AIS 1 Injuries	10%	10%	10%

Source: NHTSA, 1984

According to the above data, if air bags are added to lap/shoulder belts, then the effectiveness concerning fatality will increase by 5 percent (from 40-50 percent to 45-55 percent). On the other hand, the effectiveness of the air bag alone is 20 to 40 percent. (See Table 3-3.) This means that air bags will provide relatively small incremental benefit to current seat belt users while providing relatively large benefit to those who do not use belts.

Table 3-3 Incremental Benefit of Air Bags for Belt Users and Belt Non-Users

	Belt Users	Belt Non-users
Fatalities	5%	20-40%
AIS 2-5 Injuries	5%	25-45%
AIS 1 Injury	0%	10%

Overall, the passive restraint regulation would “punish” the current belt wearers by imposing on them a virtually unnecessary charge. In effect, they would be penalized for other drivers’ poor judgment in not using seat belts. If the regulation lead to lower fatality and injury, and thus to the lower insurance premium, that will benefit both the belt users and non-users. Moreover, one might argue that current users should already be receiving an insurance break, something insurers do not now offer, in large part (presumably) due to the problem of verification of belt use. (Warner, 1983) Overall, the passive restraint regulation could either mitigate or worsen the current “unfair” situation, depending on how the current belt users value the incremental benefit offered by air bags (or automatic belts, if any).

After the regulation was enacted, the market trend turned out to be that “safety sells,” and air bags, rather than automatic seat belts, eventually dominated the market. However, the seat belt non-users are still around 40%, though decreased from 85% of the beginning of 1980s. Also, differentiated insurance premium between belt users and non-users has not spread widely.

Incremental Benefit of Air Bags

In this section, we will discuss how much added benefit the universal installment of air bags will bring about to the society. From Table 3-2 and 3-3, the incremental benefit of fatality saving by air bags for belt users and non-users is 5 percent and 30 percent (the median value), respectively. Thus, if the belt use rate is, at the extreme, 100 percent or 0 percent, then the incremental benefit for the society is 5 percent and 30 percent, respectively. If the belt use rate is x percent, the incremental percent effectiveness of air bags for the society is:

$$5\% * x/100 + 30\% * (1-x/100) = (30 - x/4)\%$$

This means that as belt usage rate increases, the incremental social benefit of air bags will decrease.

Let us consider driver-side only air bags for simplicity. In 1982, the number of driver fatality in passenger cars was approximately 15,000 (NHTSA, 1984). Assuming that 15% of those drivers who died used seat belts and that seat belts were 45% effective in fatality reduction when used, the fatality level when no one would use seat belts is calculated as follows:

$$15,000 / (1 - 0.15 * 0.45) = 16,086$$

If driver side-air bags were installed in all passenger cars, and $x\%$ of drivers used seat belts, then the incremental fatality reduction by air bags would be:

$$16,086 * (30-x/4)/100$$

Assuming that the cost of driver side air bag is \$232, the total number of passenger cars to be 150 million, and the average life span of a car to be 10 years, the annual cost of driver-side air bags in all passenger cars would be:

$$\$232 * 150 \text{ million} / 10 \text{ year} = \$3,480 \text{ million/year}$$

From these effectiveness and cost, we can calculate the “cost per saving a life” with various belt use rate as a parameter. The result is shown in Table 3-4

Table 3-4 Estimate of Incremental Life Saving and Cost of Driver Air Bag

Belt use rate	Incremental life saving by air bags	Cost per saving a life (million \$)
0%	4,834	0.72
20%	4,022	0.86
40%	3,218	1.08
60%	2,413	1.44
80%	1,609	2.16
100%	804	4.32

The “value of life” in the United States using the “willingness to pay” method is \$2.6 million. (Willike et al. 1993) If the belt use rate can be increased to more than 85% by some countermeasures, the cost effectiveness of air bag may be controversial.

However, we should note that we omitted the benefit of non-fatal injury savings in this calculation. It is not agreed upon whether fatality and injury reduction can be measured by a single unit, even if not in dollar terms. One option is to use “quality adjusted life years” saved, which is often used in health interventions, but this requires additional data regarding patients’ record of hospitalization. The other option is to ignore

non-fatal injury reduction altogether, focusing on the fatality reduction as the only major benefit. Because the relation in the effectiveness of fatality reduction and AIS 2-5 injury reduction is roughly the same for the three restraint systems in Table 3-2, we can use fatality reduction as a good index to compare effectiveness among alternatives. Still the omission of non-fatal injury reduction considerably underestimates the overall benefit.

Comparison of Mandatory Standard vs. Mandatory Option

One way to avoid punishing seat belt users by forcing them to purchase passive restraint while giving choice to those who want passive restraints such as air bags, is for the government to seek legislation requiring automobile manufacturers to provide consumers with the option of selecting automatic restraints in some of their models. This appears to be a sensible idea, but has some problems.

First, this “mandatory option” scheme does not warrant that those who will most need the passive restraint -- seat belt non-users -- choose to buy the passive restraint option. If we assume that seat belt non-users dislike the inconvenience of having to buckle up but are conscious to their safety, then they will choose automatic seat belts. If the reason for those safety conscious people to not use belts is the discomfort of being harnessed, they will choose air bags. But if the reason for non-use is the belief that they won't be involved in accidents, then seat belt non-users would not regard the automatic restraint as necessary, and they will not buy it.

Second, under the “mandatory option” scheme, the price of passive restraints would be high, because the low volume of production does not

realize the economies of scale as much as under the “mandatory standard” scheme, and may discourage many people who would choose to buy at a lower price. In 1984, NHTSA estimated the unit consumer price of full front air bags (in addition to manual belts) at annual production level of 1,000,000 units, 100,000 units 10,000 units as \$320, \$600, and \$1,500, respectively. (in 1982 dollars)

At these prices, how many people would voluntarily choose to buy air bags? Though price elasticity of demand predicted from surveys using questionnaire is not necessarily a reliable indicator of preference revealed in the marketplace, NHTSA estimated what percentage of people would be willing to purchase an optional air bags as shown in Table 3-5.

Table 3-5 Air Bag Price vs. Percent Voluntary Purchase

Air bag price (1982 dollars)	Percent of consumers who are willing to pay
\$100	75%
\$200	55%
\$300	38%
\$400	25%
\$500	16%
\$600	8%

Source: NHTSA, 1984

Third, this “mandatory option” scheme requires a change in the statutory concept of the Safety Act of 1966. The Safety Act stipulates the “minimum mandatory standard,” i.e. no option. Then question arises as to what the “minimum safety level” that the automatic restraint regulation

intends to achieve is: whether the level achieved by those who do not wear seat belts (i.e. air bag alone) or the level achieved by the belt users (air bag with seat belts)? Since the compliance with the standard of cars installed with air bags must be verified using both belted and unbelted dummies, it seems that the “minimum” safety is the level achieved even if the occupant is unbelted. This sounds as if seat belt is the supplement of the air bag instead of being the other way around as NHTSA claims.

Fourth, this “mandatory option” plan was not welcomed by automobile manufacturers. The plan was proposed in the 1979 by Congressman Stockman as an amendment to the Motor Vehicle and Cost Savings Act of 1980 which would disallow NHTSA from enforcing any occupant restraint standard that did not provide consumers a choice between manual and passive systems. According to one Ford official, the plan was totally unworkable, because in the extreme, the plan might mean that manufacturers would have to design a manual and passive system for every line of car. (Graham, 1989)

Consideration of this “mandatory option” idea illustrates one function of “mandatory standard”: when mandatory standard requires new technology such as air bags, the standard can reduce the consumer price of the new technology through the realization of the economies of scale. It also reduces the uncertainty of market environment and enables the manufacturers to invest in the production capacity more confidently and to set prices with a longer payout period in mind.

However, in the case of 1984 automatic restraint standard, the manufacturers were allowed the option of either air bags or automatic seat

belts, and considerable uncertainty remained as to the proliferation of air bags into the market.

Summary of Chapter 3

In this chapter, we discussed the framework to judge the appropriateness of automobile safety regulation. An individual's decision on personal safety is the starting point, and then various "market failure" is considered under which the individual's decision does not lead to the optimal state from societal perspective. The social cost-benefit analysis was introduced, which assesses the appropriateness of governmental intervention from the aggregate cost and aggregate benefit of the intervention. The downside of the methodology is that the distributional issues is neglected, and that the quantification of cost and benefit is controversial. An example of the distributional effect related to the automatic restraint regulation was discussed, and an alternative approach to mandatory requirement was considered.

In the next chapter, we will examine how the decision on mandating automatic restraints was backed up by analytical evaluations.

Chapter 4

Practical Aspects of Regulatory Evaluation

Although the social cost-benefit analysis has a number of imperfections such as the neglecting of distributional effects and omission of factors difficult to quantify as discussed in Chapter 3, it is an important methodology widely used in assessing governmental programs. In this chapter, we will look at how the social cost-benefit analysis has been used in automatic restraint regulation.

First, the legal foundations that underlie the regulation is reviewed. Then, the analyses conducted before and after the promulgation of the regulation are reviewed.

Legal Foundations

Regulatory actions are based on a delegation of authority from the legislature in the form of statutory language and congressional intent (legislative history). Accordingly, the framework for assessing the appropriateness of automatic restraint regulation must take into account this legal environment.

The way in which social cost-benefit analysis is regarded as a policy making tool has changed as the social and political environment changes.

Legislation

The National Traffic and Motor Vehicle Safety Act of 1966 established the foundation of automobile safety standards. The guideline for the standards requires that the standards should:

- meet the needs for motor vehicle safety by protecting the public against unreasonable risk of death or injury in the event accidents do occur;
- be stated in terms of performance rather than design specifying the required minimum level of performance but not the manner in which it is to be achieved;
- be practicable which depends on technical feasibility, production timing and ultimate additional cost (if any) to the consumer; and
- provide objective criteria so that compliance can be determined by objective measurement. (U.S. Department of Commerce, 1967)

This rather vague guideline is a result of a struggle to establish a federal program of regulation, and has been a subject of dispute. For example, does the word “practicable” or “unreasonable risk” in the guideline require that the NHTSA perform a cost-benefit analysis? The automobile manufacturers tried but failed to get more specific language on lead time, customary model changes, and commensurability of costs and safety benefits included in the Safety Act instead of the vague practicability language. The Senate Commerce Committee went so far as to state only that while it wanted safety to be the overriding consideration on the issuance of standard, it recognized that the Secretary would necessarily

consider reasonableness of cost, feasibility, and adequate lead time.
(Graham, 1989; NHTSA, 1985)

Based on this legislative history, it seems that the NHTSA has had discretion on what kind of cost-benefit analysis to perform and whether to base their regulatory decision on the result of the analyses.

Executive Orders

An important development in administrative law came from the head of the executive branch in the 1980s. President Reagan laid out substantive principles, most notably cost-benefit analysis, intending to exert control over federal regulatory process. (Pildes, 1995)

Executive Order 12291 (February 17, 1981)

The Reagan administration ordered agencies to conduct regulatory impact analysis on proposed and currently effective rules, “in order to reduce the burdens of existing and future regulations, increase agency accountability for regulatory actions, provide for presidential oversight of the regulatory process, minimize duplication and conflict of regulations and insure well-reasoned regulations.” (Public papers of the presidents, 1981-104)

The general requirements of the order states that the “all agencies, to the extent permitted by law, shall adhere to, the following requirements” including:

- Administrative decisions shall be based on adequate information concerning the need for and consequences of proposed action;

- Regulatory action shall not be undertaken unless the potential benefits to society from the regulation outweighs the potential costs to society;
- Regulatory objectives shall be chosen to maximize the net benefit to society;
- Among alternative approaches to any given regulatory objective, the alternative involving the least net cost to society shall be chosen; and
- Agencies shall set regulatory priorities with the aim of maximizing the aggregate net benefits to society, taking into account the condition of the particular industries affected by regulation, the condition of the national economy, and other regulatory actions contemplated for the future.

The order clearly requires social cost-benefit analysis. However, the order does not specify as to how the cost and benefits shall be quantified. The procedural section of the order required that all “major” regulations be submitted to the Office of Management and Budget for general review and oversight.

Executive Order 12866 (September 30, 1993)

President Clinton’s administration reformed the Reagan initiatives concerning the federal regulatory operations by issuing a new Executive Order in September 1993. Though the new order maintains the basic process established by the Reagan orders and maintains much of the substantive focus including the emphasis on cost-benefit analysis, the new order views this analytical tool with some caution and ambivalence. The Order states that:

“In deciding whether and how to regulate, agencies should assess all costs and benefits of available regulatory alternatives, including the alternative of not regulating. Costs and benefits shall be understood to include both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to consider.”

Though specific qualitative measures are not mentioned explicitly, the order requires each agency to consider “nature of risks,” “flexibility,” “distributive impacts,” and “equity.”

Concerning the regulatory means, the order urges agencies to identify and assess alternative means to direct regulation, including providing economic incentives to encourage the desired behavior or providing information upon which choices can be made by the public.

Regulatory Evaluations

Regulatory evaluations is categorized into “ex ante” and “ex post” depending on whether the analysis is conducted before or after the implementation of the program. There is no essential difference in the objective for the ex ante and ex post evaluation in that both seek for the information that enables the judgment as to whether the program is worthwhile, but the difference lies in the information available for the analysis and the resulting method used.

Ex Ante Evaluation

Before making a decision on whether or not to adopt a governmental program (such as safety regulation), ex ante evaluation is conducted to

analyze the impact of the program. Normally, analysis focuses on the benefits (reduction in the number of fatalities and injuries), costs (expenditure for the consumers -- assuming that all the costs are passed on to the consumers) and other social effects (such as for concerned industries) that the program might have.

In the case of automatic restraint regulation, methods for obtaining necessary information includes: engineering estimation from crash tests, analysis on accident data, and the judgment of experts. Sometimes statistical field experiments with modified test vehicles in normal use are conducted. These analyses are usually focused on societal cost and benefit: the issue of who pays and who benefits is not addressed, except for the impact for concerned industry.

Effectiveness

Effectiveness of occupant restraint system means how much reduction in the chance of injury or fatality an occupant using the particular system will experience, compared to an unrestrained occupant, given that a crash has occurred.

Few air bag equipped vehicles had been sold before the regulation was enacted. As of 1984, air bag cars in use consisted of manufacturers' test fleets of 831 1972 Mercurys, 1,000 1973 Chevrolets, and 75 1975 Volvos. In addition, 10,281 1974-76 Buicks, Oldsmobiles, and Cadillacs were sold to the public, for a total of 12,187 air bag cars in the fleet.

NHTSA had attempted to keep track of fatalities and injuries in these vehicles and in a national population of approximately equivalent

cars with manual belts. However, this number of cars and cases of serious or fatal injuries were too few to generate a result with significant statistical meaning.

Consequently, the NHTSA had to explore other methods. These methods commonly utilized the National Crash Severity Study (NCSS) file as the fundamental source of accident data. The file consisted of 12,050 accidents and 924 fatalities, which were sampled according to a plan designed to result in a representative sample of tow-away accidents. Since none of the fatal accidents in the NCSS file occurred in air bag equipped vehicles, the effectiveness of the air bag was estimated by partitioning the NCSS accidents into various sub-groups by distinguishing characteristics and then making a judgment about whether an air bag could prevent or mitigate injury or fatality in that sub-group. Overall effectiveness is then calculated from a weighted total of the individual judgment within the various sub-groups.

Using this and other methods, the NHTSA estimated the effectiveness of air bags as shown in Table 4-1.

Table 4-1 NHTSA's Estimate of Percent Effectiveness of Occupant Restraints

	Manual Lap Belt	Manual Lap/Shoulder Belt	Automatic Belt	Air Bag Alone	Air Bag with Lap Belt	Air Bag with Lap/Shoulder Belt
Fatalities	30-40	40-50	35-50	20-40	40-50	45-55
AIS 2-5 Injuries	25-35	45-55	40-55	25-45	45-55	50-60
AIS 1 Injuries	10	10	10	10	10	10

Source: NHTSA, 1984

Benefit

Using the above effectiveness of various occupant restraints and the current level of traffic fatalities and injuries, NHTSA estimated the annual reduction of fatalities and injuries as shown in Table 4-2. NHTSA assumed that the lap belt usage rate for air bag equipped vehicles to be the same as the current belt usage rate, i.e. 12.5%. As for automatic belts, the usage rate was given as a parameter.

Table 4-2 NHTSA's Estimate of Annual Incremental Reduction in Fatalities and Injuries

	Fatalities	AIS 2-5 Injuries	AIS 1 Injury
Air Bags Only (No Lap Belt Usage)	3,780-8,630	73,660-147,560	255,770
Air Bags With Lap Belt (12.5% Usage)	4,410-8,960	93,480-152,550	255,700
Air Bags With Lap/ Shoulder Belt (12.5% Usage)	4,570-9,110	85,480-152,550	255,770
Automatic Belts			
20% Usage	520-980	8,740-15,650	22,760
30%	1,420-2,280	24,370-37,440	52,640
40%	2,320-3,590	39,990-59,220	82,510
50%	3,230-4,900	55,610-81,000	112,380
60%	4,130-6,200	71,240-102,790	142,250
70%	5,030-7,510	86,860-124,570	172,120
Mandatory Belt Use Laws (in all states)			
40% Usage	2,830-3,590	47,740-59,220	82,510
50%	3,860-4,900	65,300-81,000	112,380
60%	4,890-6,200	82,860-102,790	142,250
70%	5,920-7,510	100,430-124,570	172,120

Source: NHTSA 1984

NHTSA did not directly attach monetary values for these fatality and injury reduction. Instead, it calculated the reduction in the premiums for automobile insurance, as well as for health insurance and life insurance.

The calculation of these estimates are based on the assumptions: (1) the potential reduction in fatalities and injuries that are likely to result from mandated automatic restraints could produce a corresponding decrease in legal, medical and rehabilitation expenses; (2) the additional cost of automatic restraints may increase insurance company payouts for certain property damage claims such as for replacement cost of deployed air bags; and (3) these shifts in payouts will eventually reflected in the premium paid by consumers.

Three types of insurance provide coverage for injuries suffered in automobile accidents; automobile insurance, health insurance, and life insurance. For each type of insurance, potential reduction in payout is calculated from the amount of current claims payout and the effectiveness of each type of automatic restraint.

As for the cost increase related to the air bag, collision insurance, property damage liability insurance and comprehensive insurance are taken into account, for each type of insurance, the additional claims payout for replacement of deployed air bags and the added cost from scrapped vehicles without air bag deployment due to higher book value are calculated. The summary of the estimates is shown in Table 4-3.

Table 4-3 NHTSA's Estimate of Potential Savings on Insurance Premium

	Per Vehicle Annual Savings (\$)	Per Vehicle Lifetime Savings (\$)	Total Annual Savings 1990 Fleet Equivalent (\$M)
<i>Air Bags</i>			
Automobile Insurance Savings-Safety	9-17	62-115	1,108-2,046
Loss-Deployment	(3)	(18)	(312)
Health Insurance	4-8	29-54	521-962
Life Insurance	0-1	3-7	62-136
Total	10-23	76-158	1,379-2,832
<i>Automatic Belts (For 20 percent Assumed Usage)</i>			
Automobile Insurance	1-2	5-14	89-243
Health Insurance	0-1	2-7	42-114
Life Insurance	0	0-1	7-14
Total	1-3	7-22	138-371
<i>Automatic Belts (For 70 percent Assumed Usage)</i>			
Automobile Insurance	10-14	65-94	1,146-1,676
Health Insurance	5-7	31-44	539-788
Life Insurance	1	4-6	71-106
Total	16-22	100-144	1,756-2,570

Source: NHTSA, 1984

Cost

Costs of vehicle safety regulation generally involve consumer prices and other life cycle costs of safety feature. In air bags case, estimating the consumer price was complicated by the fact that the air bag had not been in full production (only one manufacturer was producing air bags in 1984). There was a substantial uncertainty about what the actual design and therefore the final components of the new system would be, because NHTSA sets performance levels but does not specify equipment design. Uncertainty about the actual volume of production was also a factor that makes precise cost estimation difficult. Moreover, cost estimates by the manufacturers of air bags and automobiles might not be necessarily reliable, since the air bag

manufacturers, being for the regulation, may be inclined to underestimate the manufacturing cost, while automobile manufacturers, being against the regulation, may overestimate.

To obtain cost estimates independent of manufacturers' information, NHTSA conducted "teardown" cost analyses of various air bag systems. In teardown analyses, all parts procured for the investigation are disassembled or torn down to identify the subassemblies and components, and gauge, dimensions manufacturing method and possible vendors are identified. Then, each part's material cost, labor costs, and manufacturing or non-manufacturing overhead are assessed. Finally consumer cost is obtained by using the estimated direct cost, adding the variable burden, factoring in the overhead, and determining the mark-up from dealer to customer.

Annual production volume affects unit cost. NHTSA estimated the relation between annual production level and unit cost of air bags in 1982 dollars as shown below.

Annual production level	Cost of full front air bags (in addition to manual belts)
1,000,000 units	\$320
300,000 units	\$340
100,000 units	\$600
10,000 units	\$1,500

In the regulatory impact analysis, the high production level (1,000,000 units) was assumed without any explanation. Though the regulation guarantees the market penetration of automatic restraints, the 1984 standard allowed manufacturers to choose between air bags or automatic seat belts. Considerable uncertainty remained at that time as to

the proliferation of air bags into the market. In 1984, NHTSA estimated the cost of air bag as shown in Table 4-4.

Table 4-4 NHTSA's Estimate of the Cost of Occupant Restraint

	Incremental Cost	Lifetime Energy Cost	Total Cost Increase
Manual Belt System	Base	Base	Base
Automatic Belt System (2pt or 3pt High Volume)	\$40	\$11	\$51
Air Bag- Driver Only (High Volume)	\$220	\$12	\$232
Air Bag- Full Front (High Volume)	\$320	\$44	\$364

Source: NHTSA, 1984

NHTSA subtracted the savings in insurance premiums from the cost of restraints and energy cost, and obtained the net dollar cost to automobile users. The summary of safety benefits and net dollar costs or benefits is shown in Table 4-5.

Table 4-5 Summary of Safety Benefits and Net Dollar Costs or Benefits

	Annual Safety Benefit		Incremental Lifetime Cost	Lifetime Insurance Premium Reductions	Lifetime Net Dollar Cost or Benefits
	Fatalities	AIS 2-5 Injuries			
Full Front Air Bags with Lap Belt					
No Usage of Lap Belt	3,780-8,630	73,660-147,560	\$364	\$66-154	\$210-298
12.5% Usage of Lap Belt	4,410-8,960	83,480-152,550	364	76-158	206-288
Driver Air Bag with Lap Belt					
No Usage of Lap Belt	2,680-6,250	56,330-114,370	232	36-100	132-196
14% Usage of Lap Belt	3,200-6,520	64,820-118,680	232	44-104	128-188
Driver and Right Front Automatic Belt					
20% Usage	520-980	8,740-15,650	51	7-22	29-44
70% Usage	5,030-7,510	86,860-124,570	51	100-144	(49)-(93)
Driver Automatic Belt					
20% Usage	270-580	5,260-10,370	26	0-8	18-26
70% Usage	3,610-5,440	67,160-96,770	26	65-99	(39)-(73)

Source: NHTSA, 1984

Other Impact of Regulation

NHTSA estimated impacts of cost increase due to the regulation on the society. These included demand for new automobiles, micro-economic effects such as losses (and gains) in passenger car sales, industry revenue, and employment, and macro-economic effects such as national employment, Gross National Product and inflation. It also included effects on small business such as seat belt manufacturers, air bag manufacturers, auto repair business, new car dealers, etc.

Discussion of the Ex Ante Evaluation

As we have seen, NHTSA estimated the effectiveness of automatic restraint regulation in terms of fatality and injury reduction, and quantified

part of the benefit in terms of savings in insurance premiums. By subtracting the savings from the regulatory cost, NHTSA obtained the net dollar cost of regulation.

Though insurance savings may be a legitimate measure of quantifying *part* of the benefit of fatality and injury saving in monetary terms, it is far from representing the whole benefit. NHTSA did not quantify the *total* benefit of life and injury savings in monetary terms supposedly because doing so is too controversial. So, what NHTSA did can be regarded as either a partial cost effectiveness analysis or a partial cost-benefit analysis.

How the Ex Ante Evaluation Relates to Regulatory Decision Making

Since the NHTSA is mandated by the Safety Act of 1966 to consider safety as an overriding concern, NHTSA takes a stance that it does not have to subject its decision to cost-benefit analysis. (Nash, 1981) Though the Executive order requires administrative agencies to conduct cost-benefit analysis “to the extent permitted by law,” and NHTSA did present the cost and benefit (in terms of fatality and injury reduction), the cost-benefit analysis does not seem to play a major role in the decision making. National Transportation Safety Board stated:

Safety benefit and cost estimates are management aids which should be used particularly in the initial stage of problem identification to assist the decision-making process. In the case of FMVSS 208, such estimates have served more as justification for decisions already made. (NTSB, 1980b)

The challenge is that in the initial stage of problem identification, information to conduct cost-benefit analysis is extremely limited especially when new technologies such as air bags are concerned. This devalues the usefulness of analytical approach further. In such case, various judgments inevitably must be made by the administrative agencies. Therefore, the ex ante evaluation needs to be taken as involving considerable uncertainty, and the importance of ex post evaluation, which will be discussed in the next section, should be emphasized.

Another point should be made here. In the ex ante analysis, NHTSA did present the cost and benefit estimates of the automatic restraint regulation, but they did not present the cost and benefit estimates of other alternatives such as mandatory seat belt use laws. Thus we can not get a sense of whether the automatic restraint regulation was the most cost beneficial approach among all options. This is presumably because the cost and benefit of mandatory seat belt use laws is even more difficult to estimate than those of the automatic restraint regulation. However, this failure emphasizes the above criticism by NTSB that NHTSA used the cost-benefit analysis as a justification for a decision already made, rather than as a decision making aid. This point deteriorates the legitimacy of the automatic restraint regulation.

Ex Post Evaluation

After a safety regulation is enacted, the effect of the regulation is evaluated, using actual operating data. Normally, evaluation compares the accident number and consequence before and after the adoption of the

regulation, or compares post-regulation accidents that are affected by the regulation and those which are not affected by the regulation.

Ex post evaluation is by no means easier than ex ante evaluation because ex post evaluation must deal with the noisy “real-world” data which ex ante evaluation can not deal with. Collecting sufficient amount of meaningful data, and isolating the effect of regulation is often difficult.

In the case of air bag regulation, after the passive restraint mandate went into full requirement in 1990, the ex post evaluation was mandated by the Congress in the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. ISTEA stipulated that:

The Secretary (of Transportation) shall biannually report, beginning October 1, 1992 and continuing to October 1, 2000, on the actual effectiveness of an occupant restraint system defined as the percentage reduction in fatalities or injuries of restrained occupants as compared to unrestrained occupants for the combination of inflated restraints and lap and shoulder belts alone.

According to this requirement, NHTSA has published three reports: interim report in June 1992, first report in January 1993, and second report in February 1996.

The analysis is based mainly on the accident data from the National Accident Sampling System’s (NASS) Crashworthiness Data System (CDS), which collects detailed information on an annual sample of approximately 5,000 police-reported traffic crashes involving passenger vehicles towed from the crash scene due to damage resulting from the crash.

There are some difficulties in estimating the effectiveness of restraint systems. First, isolating the effect of restraint system requires comparison

of nearly identical crash condition except for the usage of restraint. This naturally requires large data sets. Second, information about whether or not the restraint (in this case seat belt) was used is difficult to obtain, although this information is crucial for the accurate estimate of effectiveness. Repeated analyses have demonstrated that self-reported safety belt use overstates the level of safety belt use, especially among the uninjured vehicle occupants. This may be due to the presence of penalties for non-use of seat belts, discounts offered by some automobile insurance companies for a signed commitment that the policy holder will always use his or her safety belt, or other reasons. (NHTSA, 1996). This is the reason why the analysis had to use the NASS-CDS which is based on expert investigation instead of Fatal Accident Reporting System (FARS) which has more samples but relies solely on police reports.

In the 1996 report, the effectiveness of occupant protection systems is estimated as shown in Table 4-6.

Table 4-6 Estimated Percent Effectiveness of Occupant Restraint Systems in Reducing Moderate and Greater Injury (AIS 2+)

System Used	All Damage Areas	Front Damage
Air bag plus lap-shoulder belt	47%	57%
Air bag alone	ns	ns
Automatic (2-point and 3-point)	49%	57%
Manual lap-shoulder belt	48%	59%

Note: o Percent effectiveness means that if all occupants use a particular restraint, X% of them would escape AIS 2+ injuries which the unrestrained occupants would incur.
o ns means no statistically significant differences from the risk of unrestrained occupants.

Source: NHTSA, 1996a

It should be noted that the effectiveness in reducing moderate and greater injury (AIS 2 or greater) is almost the same for manual lap shoulder belt (48% in all damage area and 59% in front damage) and air bag plus lap-shoulder belt (47% and 57%, respectively). Though the sample size is not large enough to draw any final conclusion, the result could be interpreted to mean that the air bag offers no added benefit to the belt users in reducing injuries.

In a separate exploratory analyses, NHTSA found benefits, associated with the presence of an air bag, in reducing the likelihood of moderate and greater injury to the occupant's head, neck face, chest, abdomen and legs collectively. The injury reducing effectiveness of air bag plus lap-shoulder belt (excluding arm injury) was 59% while those of automatic (2-point and 3-point) belt and manual lap-shoulder belt were 49% and 47%, respectively. At the same time, the same type of statistical model

indicated that the presence of an air bag (either alone or with the use of a safety belt) is associated with an increased risk of AIS 2+ arm injury.

As for fatality reducing effectiveness, NHTSA used FARS data with some simplifying assumption that enables to isolate the effectiveness of air bag, without regard to the use of safety belts. The result was that the air bag reduce the fatal injuries to non-fatal ones by 28%-35% in pure frontal crashes (12 o'clock) and 15%-18% in all frontal crashes (10-2 o'clock).

In summary, the ex post evaluation on the effectiveness of air bag has not yet successfully isolated the effectiveness of the air bags due to the insufficient quantity and quality of accident and belt use data. In addition, air bags are suspected to create some injuries (e.g. in arms) while preventing others (e.g. in head, etc.). This issue deserves further investigation in collaboration with the medical community.

Summary of Chapter 4

Though not strictly required by the statutory mandate, NHTSA conducted regulatory analyses before and after the regulation was promulgated. Before the regulation, NHTSA presented added cost due to the regulation, benefit in fatality and injury saving, and quantified part of the benefit in monetary terms by estimating the savings in insurance premiums. However, NHTSA did not present the cost and benefit estimates of other alternatives to automatic restraints, such as mandatory seat belt use laws, thus failed to prove that the automatic restraint was the most cost effective safety measure. In addition, the extent to which such analyses contributed to regulatory decision making is rather modest.

After the regulation was enacted, NHTSA is conducting ex post evaluations on the effectiveness of automatic restraints using real-world data, but have not yet successfully isolated the safety benefit of air bags due to the insufficient quantity and quality of accident and belt usage data. Overall we are not yet sure whether the automatic restraint regulation can be called a success or not.

In the next chapter, we will compare the experience of the United States in occupant protection to those of the other countries.

Chapter 5

International Perspective

In this chapter, we place the experience of the United States in perspective. We address a question: Why did the United States lead in mandating passive restraint when other industrialized nations did not?

As of 1996, the United States is the only country which mandates the installment of air bags in automobiles. European countries, while the United States were struggling to mandate automatic restraint, enacted mandatory belt use laws, and achieved high belt use rate. Recently, assuming that belts will be worn by 95 percent of occupants, the European Commission is considering new standards to protect belted occupants, unlike the U.S. standard which are designed to protect unbelted occupants. (Kurylko, 1995) Japan mandated frontal barrier crash test for passenger cars in 1992, which is basically equivalent to FMVSS 208, but differs in one aspect: the dummy is to be belted during the crush test. The rationale to use belted dummy was the high seat belt use rate which is around 80 percent in Japan as compared to around 20 percent in the United States when the latter was considering automatic restraints. (IATSS, 1995)

The first explanation to the question as to why the United States leads in mandating passive restraints is that the alternative to the passive restraint -- mandating seat belt use -- was apparently not acceptable in the United States. Second, in the movement to demand more safety from vehicles rather than from drivers in the 1960s, NHTSA was established by statutory mandate in order to pursue the "technological fix," i.e. the vehicle

safety regulations. The agency initiated and strongly championed, though with some deviation at times, the air bag regulations. Third, there were strong proponents of passive restraints such as Ralph Nader and the insurance industry, and they could exert their influence through certain political channels. These factors comprised a social and political environment that was favorable to the passive restraint, and only in the United States did all these factors coexist.

Opposition to Mandatory Seat Belt Use Law

Passive restraint had one simple alternative: the use of the manual seat belts which were readily available in most vehicles. Other industrialized countries adopted this alternative and mandated belt use beginning in 1970s as shown in Table 5-1. In the United States, however, the idea of mandatory seat belt use was long considered to be infeasible. There was strong opposition to such laws because of the belief that it would be an infringement of personal freedom. From 1970 to 1980 the rate of safety belt use among motorists in the United States was persistently low, less than 20 percent based on numerous roadside surveys. (Grimm, 1980)

Table 5-1: Countries with Mandatory Safety Belt Use Laws

<i>Country</i>	<i>Date Instituted</i>	<i>Usage Rates (%)</i>
Australia	1/1/70	87
Austria	7/15/76	33
Belgium	6/1/76	87
Brazil	1977	
Bulgaria	7/1/76	
Canada (7 prov.)	75-84	50-60
Czechoslovakia	7/75	66
Denmark	1/1/76	75
Finland	7/1/75	93
France	7/1/83	78
Greece	12/16/79	
Hungary	7/1/77	
Iceland	1983	60
Ireland	2/1/79	46
Israel	7/1/75	70
Ivory Coast	1970	
Japan	12/1/71	21
Luxembourg	6/1/71	
Malawi	1982	
Malaysia	4/1/79	
Netherlands	6/1/75	67
New Zealand	6/1/72	67
Norway	9/1/75	90
Puerto Rico	1/74	
Portugal	1982	
South Africa	12/1/77	62
Spain	10/3/74	67
Sweden	1/1/75	80
Switzerland	1/1/76	81
Turkey	1982	
United Kingdom	1/83	95
USSR	1/1/76	
West Germany	1/1/76	54
Yugoslavia	1/1/77	

Source: Grimm (1984)

There is also a jurisdictional problem. In the United States, state governments have a jurisdiction over behavior related to motor vehicle use

such as driving while impaired and obeying speed limit, and potentially, using seat belts. The federal government can only encourage state governments to adopt certain vehicle usage laws by using federal highway funds as an incentive.

Following the success of Australia in first mandating belt use in 1970, NHTSA approved a plan to include mandatory seat belt use laws as part of its periodic evaluation of state highway safety plans under the 1966 Highway Safety Act. Though twelve states considered belt use laws in 1972, none were enacted into law.

In 1973 and 1974, there was a move in Congress to encourage states to adopt seat belt use laws. The Highway Safety Act of 1973 provided a bonus of 25 percent of federal highway money to each state that enacted a law mandating the use of seat belts, and another 25 percent incentive grant was available to those states that achieved the most significant reductions in their highway death rate. Though the passage of the 1973 Act induced thirty-two states to discuss mandatory seat belt laws, the public anger against the ignition interlock, which had already been put into use, marginalized the chances of the passage of such laws.

Linking seat belts with the ignition interlock exemplifies a case where anger against the intrusion into personal freedom exploded. As was mentioned in chapter 2, NHTSA permitted the ignition interlock in 1972 as an alternative to other passive restraints for vehicles manufactured between 1973 and 1975. Soon after the introduction of vehicles equipped with interlock, users began complaining about the inconvenience and intrusiveness. Congress repealed the standard in 1974 by allowing

consumers to choose either ignition interlocks or a warning system (a buzzer and lights).

After the incentive grants were withdrawn during the anti-interlock movement, the nation wide attempt to establish state seat belt use laws was shelved until 1984 when Elizabeth Dole linked such laws with passive restraints.

The Mandate of NHTSA

In contrast to the de-centralized nature of institutional settings for laws pertaining to behavioral aspects of vehicle usage, the United States had established a strong national institution for automobile safety standards in the National Traffic and Motor Vehicle Safety Act of 1966, the National Highway Traffic Safety Administration.

As mentioned in chapter 2, underlying this movement were the growing severity of road traffic accidents and the increasing political significance of the problem. At the same time, a trend of thought had emerged that vehicle design, rather than human behavior, was the key to safety improvement. Some congresspersons adopted this school of thought and began advocating for a new legislation that would force automobile manufacturers to invest more in the safety of their products. It did not take much time for the proposed legislation to get finally approved. Although the simultaneously-passed Highway Safety Act of 1966 assigned NHTSA to oversee state highway safety programs, NHTSA's *raison d'être* was the promulgation of safety standards for vehicle hardware stipulated in the Vehicle Safety Act.

Based on this mandate, NHTSA was inclined to rely on vehicle performance rather than on driver behavior. As for occupant protection, there was a strong interest in some administrators of NHTSA for passive restraint. William Haddon, NHTSA's first administrator, believed that vehicle crashworthiness was the key to safety progress, and had little interest in state programs or behavioral strategies. (Graham, 1989) Joan Claybrook, NHTSA's fifth administrator, made little effort to encourage belt use laws and was criticized by advocates of belt use for her inaction. Preoccupation of NHTSA with the air bag perhaps contributed to the long controversy and resulting delay of the regulatory process.

The NHTSA has reacted strongly supporting its rule but, because of its investment in the air bag, has defended the air bag when it should have been defending the more general concept of required levels of occupant protection. To this extent, the NHTSA itself has contributed to much of the controversy which has surrounded FMVSS 208. (NTSB, 1980b, pp.15)

It does not seem to be a coincidence that the rule made by Secretary Dole in 1984 which was meant to allow the choice between mandatory seat belt use laws and the passive restraint standard ultimately put an end to the controversy. As explained in chapter 2, she satisfied both opponents and proponents of air bags, and thus succeeded in creating a compromise.

Though the adherence of NHTSA might have lengthened the controversy it seems nonetheless true that without the initiative of NHTSA on the air bag issue, the eventual proliferation of air bags would have been still slower.

The Role of Pro-Safety Interest Groups

One of the major factors that led to the passive restraint was the role of pro-safety interest groups. The two major parties are the safety advocacy group and the insurance industry. These groups applied a great pressure on the NHTSA especially when the agency was reluctant to proceed with the automatic restraint regulation. In other countries, we do not see such safety advocacy groups. In addition, the insurance industry in other countries is not as active as in the United States. We briefly look at their role in the passive restraint controversy.

Safety Advocacy Groups

Ralph Nader and the Center for Auto Safety was the most prominent safety advocacy group. His book "Unsafe at Any Speed: The Designed-In Dangers of the American Automobile" published in 1965 (Nader, 1965) made the vehicle safety issue very visible to society and paved the road for the Safety Act of 1966. Since passage of the Act, he has consistently criticized the automobile manufacturers for their reluctance to devote more resources to safety. Nader also insisted on stricter federal standards. As early as 1969, Nader called the air bag "an exciting development" but deplored the relatively small amount of investment in research and development.

In 1978 Ralph Nader and Public Citizen (his group) sued NHTSA claiming that the implementation of the passive restraint standard should be hastened, though this suit was not successful. Joan Claybrook, who once was Nader's associate, became the administrator of NHTSA in the Carter

Administration, and strongly championed passive restraint regulation. After her terms in the NHTSA between 1977 and 1980, she began barraging NHTSA, as the president of Public Citizen.

Insurance Industry

Another interest group that actively advocated the passive restraint was the insurance industry. As introduced in chapter 2, the insurance industry's commitment to the traffic safety policy is said to be based on its financial stake in the level and trend of traffic accidents. Since change in insurance premium tends to lag several years after the amount of claims changes, the industry's profit tends to increase as the accident level goes down. Since the downsizing of vehicles is expected to worsen the accident consequence, and to have unfavorable effects on the industry's profit, the insurance industry has been eager to advocate for policy that will enhance traffic safety to balance this.

The insurance industry has a research and public relations organization called Insurance Institute for Highway Safety (IIHS). It was founded in 1959 and is supported by insurance companies. William Haddon, on leaving the NHTSA as the first administrator, became president of the IIHS; it has since become a major party in the traffic safety policy.

The insurance industry's involvement in passive restraints took several forms. Allstate Insurance Company offered a 30 percent discount on medical and no-fault personal injury coverage for air bag-equipped vehicles in the mid 1970s. Allstate also purchased for its fleet 200 air bag equipped 1976 model year vehicles from GM. The industry's executives testified in

favor of passive restraints at Congress hearings. The most aggressive and effective move was the suit by State Farm Insurance Company against the NHTSA when the passive restraint standard was rescinded in 1981. It eventually won the Supreme Court's rule that NHTSA was "arbitrary and capricious" in rescinding the standard which led to the subsequent Dole rule.

Nature of Policy Making

The role of the above pro-safety groups is closely related with the American nature of democratic decision-making known as pluralism: there is no single decision-making power center, but the power is distributed among the legislative, executive and judicial branches, not only nominally but also in actuality. The authority to promulgate vehicle safety standards is delegated by the Congress to the Department of Transportation. But this authority is readily checked by the other branches of the government: the Congress can override the DOT rule and an opponent can challenge the DOT rule in federal court.

These checks and balances work quite well in the United States in an open and adversarial manner when compared with the closed and consensual approach in European nations such as Great Britain. (Irwin, 1985) Pro-safety groups made the most of this decision making system in asserting their advocacy of the passive restraints.

Summary of Chapter 5

In this chapter, we have discussed the factors that contributed to the United States' adoption of the automatic restraint standards that eventually mandated air bags in automobiles. This is the only such mandate in the world.

Opposition to mandatory seat belt use and the strong belief in automatic restraints by their proponents, together with the institutional settings in favor of technological rather than behavioral solutions, and the open and adversarial nature of policy making, were the most influential factors to this development.

In the final chapter, we will summarize the discussion made so far and draw conclusions.

Chapter 6

Summary and Conclusions

This thesis intended to evaluate the public policy of the United States that ultimately mandated the installment of air bags in automobiles as a safety device. We first reviewed the history of the long and fierce controversy on the automatic restraint regulation, and then discussed the framework to assess the appropriateness of the countermeasures for occupant protection. The relation between such a framework and actual policy making was then reviewed; this was followed by a comparison of the experience of the United States to other country's approach to the same problem.

In this final chapter, we will summarize our research, draw some conclusions, and suggest future research.

Social Cost-Benefit Analysis and its Limitation

We discussed the framework to assess the appropriateness of the occupant restraint regulations. First, we examined the decision of individual occupants on the use and/or purchase of restraints from economic perspective, and found that three market failures exist: the lack of information among consumers or users, the lack of competition among suppliers, and the externality of accident costs. Depending on the nature of the imperfection, individual decisions do not lead to optimal allocation of resources from the standpoint of the individuals and/or society, and thus the need for the intervention to remedy the imperfection arises.

The first priority for societal intervention, in the opinion of economists, would be programs which directly address the market imperfection such as consumer information program, effective liability and insurance system, and antitrust action against the manufacturers. However, due to various practical difficulties and questions of efficacy accompanying such market-oriented intervention, more direct intervention - governmental fiat such as mandatory seat belt use laws or mandatory air bag installment in cars, for example -- may be given higher priority.

Since it is very difficult to know the level of safety that would be achieved if the market failure could be eliminated, governmental fiat takes a risk of imposing more safety than would be achieved under the perfect market for safety. To avoid this "over-consumption" of safety, we need a workable desirability criterion with which to judge whether a coercive intervention is warranted. We started from Pareto optimal statement, and accepted the Kaldor-Hick test which assumes the compensation from those who are made better off to those who are made worse off. This allows us to aggregate the cost and benefits of intervention programs: the social cost-benefit analysis. However, the practical difficulty of compensating losers by winners makes the implementation of this compensation hypothetical, and allows criticism that the social cost-benefit analysis ignores the uneven impacts of the program (i.e. distributional effect) altogether.

Another problem is the validity of measuring the benefit of injury and fatality reduction in monetary terms. Due to the practical difficulty in quantifying the cost and benefit for each individuals affected by the

intervention, social cost-benefit analysis tends to use a surrogate value of fatality and injury avoidance.

To avoid the controversial valuation of life in monetary terms, the cost effectiveness analysis, which compares the “cost per life saved” in different programs, is also used. The disadvantage of cost effectiveness analysis is that it can not determine the relative desirability between a program and the “status quo.” In addition, what program alternatives to take into account is often controversial.

Due to these shortcomings, the social cost-benefit analysis and cost effectiveness analysis thus far have been of limited use in practical policy making process. In fact, as was the case with the automatic restraint regulation, the distributional effect could be a major factor that blocks the implementation of a program. As we saw in the history of the regulation, only political deliberation could resolve the controversy. However, despite the shortcomings, the social cost-benefit analysis and cost effectiveness analysis are among the few methods that enable us to judge the appropriateness of social intervention in a relatively objective manner.

Though this thesis generally adopted a perspective of economists, other perspectives are also discussed. Public health professionals rely less on the “rationality” of individuals, and tend to prefer countermeasures such as passive restraints that do not rely on individual behavior. They also tend to focus more on benefits than on costs of countermeasures.

*Balance between Individual and Societal Approach - What Did
“Automatic” Restraint Regulation Achieve?*

The first motivation to mandate air bags was to offer a countermeasure to the low use rate of seat belts in the United States: to save even those who refuse to buckle up. The “minimum safety level” that the air bag regulations intend to achieve is still the level achieved by those who do not wear seat belts (i.e. air bag alone) in that the standard specifies the injury criteria using both belted and unbelted dummies.

However, in the course of the development of air bags, it became clear that air bags alone can not achieve the safety level that is achieved by manual lap and shoulder seat belts: engineers and administrators found that air bags could not be substituted for seat belts. However, as more people learned to buckle up, and as the societal demand for safety presumably increased, the situation gradually emerged where people perhaps did not want to choose between seat belts and air bags. (Kahane, 1994) Instead, people presumably wanted both of them, since air bags, rather than automatic seat belts, began to dominated the market from the late 1980s to the early 1990s. Thus, the relation between air bags and seat belts has changed: from a substitute for each other to the supplement of each other. As the air bag itself was mandated (i.e. the automatic seat belt was eliminated as a compliance technology) by Congress in 1991, the concept of “automatic” protection expired: manual lap-shoulder seat belts were mandated to be installed in addition to air bags. (Although for those who do not use manual belts, the air bag itself is still automatic.)

Still, the automatic restraint regulation may have achieved what it did not apparently intend to achieve: the 1984 rule provided the choice between automatic restraints and the mandatory seat belt use laws. This rule acted as a catalyst to make people more safety conscious through the campaign for mandatory belt use on one hand, and to let the automobile manufacturers gradually change their strategy toward “safety sells” on the other. Although it is difficult to verify whether motorists have become more safety conscious than before, the manufacturers’ marketing strategy is a useful indicator of the people’s demand. The societal approach which intended to coerce people to consume more safety regardless of individual preference perhaps inadvertently succeeded in creating a social trend towards more safety at least in terms of automobile equipment.

Overall, can we say that the air bag regulation have been a success for the U.S. society? It took a very long time to reach where we are today, and it is still not clear. From the public health perspective, which focuses more on the benefit of life saving and not as much on cost, we can say that the regulation was a success in that the regulation must have saved a certain numbers of fatalities and injuries.

From the economic perspective, however, we are not sure if it is a success, because perhaps we could have allocated our resource in a potentially better alternative such as more aggressive campaign for mandatory seat belt use as other industrialized nations did. Resources could have been allocated in very different directions: to enforcement of drunken driving laws, following up to keep these drivers off the road, and many other approaches. That the investment in air bags was optimal is far from

clear. The point that the belt user is penalized by being forced to pay for air bags which give them small incremental benefit also makes the evaluation ambiguous.

However, as a pragmatic way of improving safety, the automatic restraint regulation has had a positive impact.

Implications for the Future

We have two different approaches for improving traffic safety: one addresses individual behavior, and the other addresses the social environment. Concerning the occupant restraints, encouraging or coercing seat belt use is the individual approach, while automatic restraint regulation is the societal approach. The two approaches are not mutually exclusive but should reinforce each other, and the balance of the two approaches depends on various social and political factors as we have seen. Although the United States has traditionally relied on societal approach rather than the individual approach, it now has an opportunity to pursue various individual approaches, since the safety consciousness of people seems to have increased considerably due to various factors including the past societal approach.

One example of such approach towards individuals is to strengthen the enforcement of mandatory seat belt use laws. Though all states except one (New Hampshire) have enacted some kind of belt use laws, about four fifth of them are “secondary” enforcement, i.e., the police can only ticket a violator if he is stopped by the police for another traffic violation, as opposed

to the “primary” enforcement where the police can stop violators even when the only violation is belt non-use.

Another possible direction for the future is various incentives to promote belt use. So far, incentives such as differentiated insurance premium and coverage for belt users and non-users are not widely implemented due to practical and theoretical difficulties, as discussed in chapter 3. However, in a country that respects individual freedom and responsibility, strengthening the enforcement of mandatory seat belt use has its limitation. Therefore, non-coercive measures like insurance incentives could be a supplemental measures worth exploring. This will also lead to a socially fair situation in terms of sharing accident costs.

Another implication for the future concerns the use of analytical tools for regulatory decision making. As a tool to assess the appropriateness of a proposed intervention from the standpoint of society, social cost-benefit analysis has its own merits and shortcomings as mentioned in chapter 3; we should apply the tool with caution in mind. However, the direction of effort should be towards refining the tool rather than dismissing it. Supplementing the aggregate analysis by explicitly presenting and discussing distributional effects (i.e. who pays and who benefits) of a proposed regulation is an example of such refinement.

Implication for Other Countries

The mandating of air bags in the United States is a result of social, political and economic factors many of which are peculiar to the country, as we discussed in chapter 5. Though the rest of the world, especially

industrialized countries, was taking a different measure (mandatory seat belt use laws) for the same objective, the movement for safer vehicles in the United States has a noticeable effect on the policy of other countries.

For example, Japan and Australia have adopted similar standards on crashworthiness based on the United States' frontal crash test with dummies, except in the aspect that they use belted dummies. These countries definitely benefited from the experience of the United States in that they could borrow data on cost and effectiveness, albeit incomplete, and could modify the U.S. standard to fit to their own social environment rather than making a standard from scratch as the United States had to.

On the other hand, the United States is following other industrialized countries in the effort to increase seat belt use. Thus it seems that the United States and the rest of the world are converging in their means of improving occupant protection: the combination of air bags and seat belt use.

The process of rulemaking in the United States, as highlighted in the controversy on automatic restraint regulation, is something other countries could draw lessons from. The open and adversarial nature of the decision-making process in the United States enables pro-safety actors such as consumer advocates and the insurance industry, which have a much less influential role in other nations, to act as a counterbalance to the automobile industry in the pursuit for road safety. Though too much confrontation could delay and inhibit the timely adoption of effective countermeasures, openness of discussion has the advantage of broadening the range of alternatives.

Conclusions

The principal findings of this thesis are the following.

1. The automatic restraint regulation was a pragmatic solution in the United States to the problem of low seat belt usage. Air bags have contributed to the reduction of occupant fatality and injury.

2. The social cost-benefit analysis and cost effectiveness analysis can be useful analytical tools to assess regulatory programs if their shortcomings are explicitly and appropriately taken into account.

3. Whether the automatic restraint regulation was the optimal safety investment from an economic standpoint was not at all clear before the regulation was enacted, and even after the air bags have spread considerably on American roads, it is still not clear.

4. The long and fierce controversy on the air bag regulation was the inevitable consequence of the pluralistic decision-making process of the United States which has its own merits and shortcomings.

5. The automatic restraint regulation perhaps inadvertently induced a trend in the automobile manufacturers and presumably in consumers towards pursuing more safety features in automobiles.

Future Work

The air bag regulation was ambitious and unique in that it was the first automobile safety standard to force the use of safety features that had not seen any use prior to the start of rulemaking (Lorang, 1977).

Consequently, various uncertainties about the possible outcomes of the regulation was large compared to other regulations. How such uncertainty was dealt with and its relation to such factors as the level of the administrative agency's technical expertise and its apparent intention, are interesting topics for further study.

Ex post evaluation of air bags is also a critical area for further investigation. Though the air bags are proliferating on American roads, the data needed to assess the real-world effectiveness of air bags are not easy to obtain, as discussed in chapter 4. More collaboration between NHTSA and the medical community will lead to more accurate and informative data on effectiveness and benefits, as well as on some side effects of the air bag. This will contribute to the refinement of the design of air bags and to the improvement of the air bag standard.

A Final Comment

Safety and the individual vs. the societal approach to it is a complex area. We hope that this research on the U.S. air bag regulations has shed some light on this question and can be of use to policy makers working in this and related areas.

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