FINAL REPORT

Contract 02-310
Project No. 008545

Analysis of Auto Industry and Consumer Response to Regulations and Technological Change, and Customization of Consumer Response Models in Support of AB 1493 Rulemaking –

Automaker Response to Passive Restraint Regulation with respect to Actions, Economics, Technology and Marketing

Airbag Case Study for the Analysis of Auto Industry and Consumer Response to Regulations and Technological Change in Support of AB 1493 Rulemaking

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October 18, 2004

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Acknowledgments

This Report was submitted in fulfillment of Contract 02-310, Project No. 008545 *Analysis of Auto Industry and Consumer Response to Regulations and Technological Change, and Customization of Consumer Response Models in Support of AB 1493 Rulemaking* by the Institute of Transportation Studies at the University of California, Davis under the sponsorship of the California Air Resources Board. Work was completed as of October 18, 2004.

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ABSTRACT

This report examines the history of passive-restraint regulation in the U.S. for 1970-2003, with special emphasis on airbag systems. The first passive restraint standard was adopted in 1984, but successfully contested by the automotive industry until 1991 as being too costly. All light duty vehicles sold in the US now must contain a dual frontal airbag system, and the cost has fallen dramatically over time. Automakers have responded to the passive restraint regulation with a variety of pricing, marketing, and financing strategies. The following insights were gained. First, greater regulatory flexibility provides automakers with the opportunity to utilize a greater array of product marketing tools, which leads to lower costs. Second, the cost of complying with passive restraint regulations seems to have had little effect on vehicle sales, both overall as well as across product lines. Third, the nature of the statutory authority and the design of the regulations affected the length of debate, with implications for speed and cost of compliance. Overall, the cost impact of the safety rules on automakers was largely offset by a variety of automaker behaviors and strategies, and eventually by increasing consumer demand for safety.

EXECUTIVE SUMMARY

Background

AB 1493 requires CARB to propose a set of rules that would improve the greenhouse gas emissions of light duty vehicles in California. To provide insight into how future regulations of greenhouse gas emissions might impact automakers and consumers, this case study examined historical federal passive restraint rulemaking. Determining automaker behavior in response to regulation is a difficult task due to the complexity of the market and the guarded nature of industry practices. The first passive restraint standard was passed in 1984, calling for all model year 1990 passenger cars sold in the U.S. to be equipped with a passive restraint system. In 1991, after a long fight between automakers and regulators, legislation was passed that effectively made the passive restraint standard an airbag mandate. Today, all light duty vehicles sold in the U.S. must contain a dual frontal airbag system. This report examines the history of passive-restraint regulation in the U.S. for 1970-2003, with special emphasis on airbag systems.

Findings

The cost of airbag systems fell dramatically as production ramped up and economies of scale were realized. Automakers employed a variety of strategies in meeting the passive restraint regulation. Once airbags were mandated, some automakers rushed to place airbags across their entire vehicle line, while others introduced the technology more gradually. Increased costs to meet airbag regulation had little impact on the volume and mix of vehicle types offered at the time the regulation went into effect. During the period of regulatory debate, automotive industry forecasts tended to overestimate the future cost of airbags, sometimes intentionally by assuming limited production volumes and atypical amortization schedules, while government and advocacy groups often underestimated costs. The prolonged struggle over the federal government's passive restraint regulations resulted in compromised rules and vehicle strategies that had a lower benefit-cost ratio than alternative strategies and rules.

In pricing vehicles, automakers handle the added cost of airbags much as they do other new technologies, and quality improvements generally. Vehicle pricing is a complex process aimed at achieving the corporate objectives of maximizing profit and market share.

Automakers employ a number of strategies to recoup the cost of a new technology such as airbags. In this case, as shown later, auto manufacturers passed most of the added cost of airbags onto consumers, but not necessarily in a straightforward manner. In general, automakers pass costs incurred by regulation through vehicles that are in higher demand and/or have a higher profit margin. Automakers may recoup the cost over a number of years to avoid price shock. Offsetting reductions in standard equipment (decontenting) on some models and a disproportionate raise in dealer (inventory) cost may be used to mitigate the effects of cost pass-through pricing. Such cost recovery behavior will differ somewhat between unregulated in-demand technologies and regulated technologies that consumers do not value.

In this age of creative financing plans and significant financial incentives, including rebates, automakers have an array of marketing tools, in addition to advertising, with

which to generate customer demand. In the case of airbags, advertising played a prominent role in educating consumers about the technology and creating demand for this and other safety features. Automakers that pioneered the introduction of airbags (e.g. Mercedes and Chrysler) derived substantial "halo effects" that aided their overall marketing.

Conclusion

Although automakers resisted the passive restraint rules, they eventually responded fully and effectively. They did so in ways that mitigated the economic impact. The initial high cost of airbags was the principal source of concern about the passive restraint standard by automakers. But once airbags were introduced, costs fell dramatically. The safety devices were added across all vehicle segments, with no little or no impact on quantity or mix of sales. Three findings stand out. First, requirements that industry introduce new technologies or products should be made as flexible as possible with appropriate phase-in periods to allow opportunity to utilize the many economic and marketing tools at their disposal. Second, in this case, the cost of compliance may have had some impact for the first year or two after regulation, but the impact on sales across the industry appears to have been negligible. Third, the nature of the statutory authority and the design of the regulations strongly affect the length of debate, which in turn delays the implementation of the rules, and compromises the cost-effectiveness of automaker responses.

1 INTRODUCTION

This report examines automaker behavior in response to passive-restraint regulation roughly from 1970 to 2000. The report consists of the following three sections.

- ***Regulatory Stimulus*** – This section will detail the timeline of the proposed and enacted passive restraint regulation. The installation rate of airbags over the time period of interest will also be presented here.

- ***Industry Response*** – The focus here is the relationship between cost and price. The analysis here first reviews cost and option price information for airbags as reported in media, academic, industry, and government records and sources. An original analysis is also conducted of the costs of integrating an airbag system into a vehicle. The analyses presented here examine automakers *decontenting* to keep prices down when airbags are added. Cost estimates for airbags and airbag components, along with a technology that was not regulated, anti-lock braking systems (ABS) are estimated and evaluated. A discussion follows of the business, job and wealth creation engendered by the nascent airbag industry to further elucidate the economic impact of the regulation. Marketing practices used by the industry to facilitate the adoption of an airbag regulation will be analyzed as well to address how automakers repositioned themselves from their adversarial position toward regulation in order to effectively promote the new safety features.

- ***Consumer Response*** – This section examines the impact of airbags, and the resultant price increase, on vehicle sales. The marketing strategies for promoting more 'public good' type attributes related to safety, environment and fuel economy are examined. Other impacts on consumer behavior will also be analyzed.

1.1 BACKGROUND

The history of Motor Vehicle Safety Standard 208, which governs passenger restraint systems in motor vehicles, is complex. This standard lays the foundation for the repeated governmental attempts at airbag regulation that were finally realized with the inclusion of the airbag mandate in the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. The history leading up to this point was filled with avoidance strategies by the auto industry and regulatory compromises that shifted from one presidential administration to another.

The automobile industry in the U.S. was relatively free of government regulation in the 1960s, until mounting concern over air pollution and traffic safety, and later energy use attracted the attention of policymakers. Both the Environmental Protection Agency (EPA), which regulates vehicle emissions, and the National Highway Transportation Safety Administration (NHTSA), which regulates vehicle safety, were established in late 1970 under the Republican administration of President Nixon.

The explicit goal of NHTSA is to "…reduce deaths, injuries and economic losses resulting from motor vehicle crashes. This is accomplished by setting and enforcing safety performance standards for motor vehicles and motor vehicle equipment, and through grants to state and local governments to enable them to conduct effective local highway safety programs."[1] Congress directed that Federal safety standards should be specified in such a manner that "the public is protected against unreasonable risk of crashes occurring as a result of the design, construction, or performance of motor vehicles and is also protected against unreasonable risk of death or injury in the event crashes do occur."[1] The question of which strategy is most effective and desirable – altering driver behavior or improving technology – played a key role in the airbag debate, and continues to underlie debates about how best to improve safety. NHTSA has historically pursued active technology-forcing rules, requiring improvements in auto safety that were ahead of current technology. The courts have supported this approach. For example, the U.S. Court of Appeals upheld the authority of NHTSA to issue an airbag rule in 1972, stating that the agency "is empowered to issue safety standards which require improvements in existing technology or which require the development of new technology, and it is not limited to issuing standards based solely on devices already fully developed."[2]

After years of deliberation, a passive restraint standard was passed in 1984, requiring that 100% of new cars be equipped with airbags starting with the 1990 model year. There were alternative ways to satisfy the standard other than airbags, so even on 1990 model cars, airbag penetration was minimal. This changed in 1991, when the sweeping new transportation bill, the Intermodal Surface Transportation Efficiency Act (ISTEA) included a provision mandating the use of dual airbags on all vehicles sold in the U.S. beginning with the 1998 model year for passenger cars and 1999 for light trucks.

By 2003, over 117 million (54.6%) of the more than 216 million cars and light trucks on U.S. roads were equipped with dual airbags. Another 21 million vehicles had only a driver-side airbag. NHTSA has estimated that as of August 2003 12,776 people are alive today because of an airbag.

1.2 RESEARCH APPROACH

The regulatory history of passive restraint standards is well documented in government sources, the media, and the scholarly literature; but the costs of complying with the rules, and how industry and consumers responded to the rules and technologies is not well understood.

Methods

The following analysis employs a case study approach, which is a form of qualitative descriptive research. While case studies are by definition context-specific, and as research, do not exhibit generalizability, automaker behavior in response to this specific regulation can in many ways be considered indicative of such conduct toward regulation overall. As a result, the emphasis of the paper will be on exploration and description, addressing questions of who, what, where, how much, and how many.

Many studies used average estimated costs of airbags, but these numbers are highly uncertain and disparate. Industry, government and lobby groups generated a wide range of cost estimates over the years that used widely varying assumptions and methods. A number of NHTSA-sponsored teardown economic analyses of real airbag systems in the late 1980s and 1990s are the most reliable sources for cost information. We contacted a number of airbag suppliers and two OEMs to elicit cost and pricing information, but they were unwilling or unable to provide authoritative data.

The first step in this airbag case study is a brief overview of the regulatory history and a description of the penetration rates of the technology after the standard was enacted. We then analyze industry response by first detailing costs and prices for airbag components and systems as reported in mass media, academic, industry, and government records and sources, including an original analysis of the cost of integrating airbag systems into a vehicle. A wide variety of industry responses to these safety regulations were examined, including *decontenting* (making standard features such as air conditioning or anti-lock brakes optional), pricing and marketing practices, and advertising. The response of consumers to these new technologies was also examined in terms of prices, passenger car sales, and the public and private good nature of the new technologies. In addition, parallels and contrasts with other regulations such as emissions standards were identified, and an attempt was made to ascertain areas where lessons learned from the passive restraint standard record could be applied to future government actions with respect to greenhouse gas (GHG) emissions.

2 HISTORY OF PASSIVE RESTRAINT REQUIREMENTS

> *…the automobile industry waged the regulatory equivalent of war against the airbag and lost.*[3]
>
> -The Supreme Court, 1983

While the legislative discussion of passive restraints began as early as the 1960s, it took many years before the first rules and laws were passed. Throughout the public debate that took place in the media and in Congressional hearings, the focal technology of the pending regulation never wavered. The focus was the airbag. The auto industry consistently diverted attention away from airbags in favor of competing technologies thought to be much less costly to implement. Meanwhile, the NHTSA-Insurance coalition touted airbags throughout, but had difficulty fully allaying the concern of Congressmen and others about the cost, safety and public acceptance of airbags. Hence it was not just an issue of cost, but rather a small array of factors that delayed the adoption of the regulation.

2.1 FMVSS 208 DEVELOPS INTO AN AIRBAG MANDATE

NHTSA was committed to making the passive restraint regulation a performance standard that could be met with different technologies. The agency retained this principle throughout the period of time leading up to the regulation, but then along with Congress discarded it when an airbag mandate was passed in 1991. After airbags were designated as the only available technology suitable for passive restraints, the regulation still had the characteristics of a performance standard. This meant that the criterion for an acceptable airbag system was based on crashing vehicle platforms with dummies at a certain speed into a fixed barrier.

2.1.1 The Passive Restraint Requirement Issued By Secretary Dole

On July 11 1984, Secretary Dole announced a passive restraint requirement to be phased in starting with the 1987 model year. Under the new rule, auto manufacturers could satisfy the standard "by using automatic detachable or nondetachable belts, airbags, passive interiors, or other systems that will provide the necessary level of relief."[4] Anticipating that most automakers would opt for the less expensive option, namely automatic safety belts, the rule provided incentives for new technologies by giving a 50% additional credit for each car equipped with either airbags or a soft interior system developed by GM. But Dole also declined to agree with the notion that automakers would necessarily choose the cheapest way out. Dole stated that "the Department does not agree with this contention. It believes that competition, potential liability for any deficient systems, and pride in one's product would prevent this." By extending this logic, automakers would forgo cheaper, potentially less safe restraint systems in favor of safer alternatives - such as the one the agency identified as the safest alternative of all: "An airbag plus a lap and shoulder belt."

Secretary Dole allowed an escape route from the regulation for the automakers if states comprising two-thirds of the U.S. population were to pass mandatory seat belt usage laws before April 1, 1989. The law would subsequently be rescinded if this threshold were met. Partly in response to the U.S. Supreme Court's finding that her predecessor's decision to rescind the standard was "arbitrary and capricious" for its failure to consider an "airbag specific" requirement, Secretary Dole responded as follows:

- First, comparing the two, she said that "[a]lthough airbags may provide greater safety benefits, when used with belts, and potentially larger injury premium reductions than automatic belts, they are unlikely to be as cost effective."
- Second, Secretary Dole expressed concern that, due to public unfamiliarity with the technology, a government-mandated "airbags only" rule "could lead to a backlash affecting the acceptability of airbags."
- Third, Secretary Dole noted that several commenters "questioned the Department's authority to issue an 'airbags only' standard, claiming that it would be a 'design' standard." She said that, "[e]ven if the Department could legally issue a performance standard that could only be met by an airbag under present technology," doing so would create "a number of problems" and could "unnecessarily stifle innovation" in other types of passive systems, such as automatic belts and passive interiors.

The phase-in schedule was set as follows:

- Ten percent of all automobiles manufactured after September 1, 1986 (1987 model year).
- Twenty-five percent of model year 1988 automobiles.
- Forty percent of model year 1989 automobiles.
- One-hundred percent of model year 1990 automobiles.

2.1.2 The Intermodal Surface Transportation Efficiency Act of 1991

On December 18, 1991, President Bush signed the Intermodal Surface Transportation Efficiency Act of 1991. Buried deep in the bill, which allocated $155 billion to various transportation activities over six years, was a requirement that all automobiles and light trucks sold in the U.S. must be equipped with airbags. It required that:

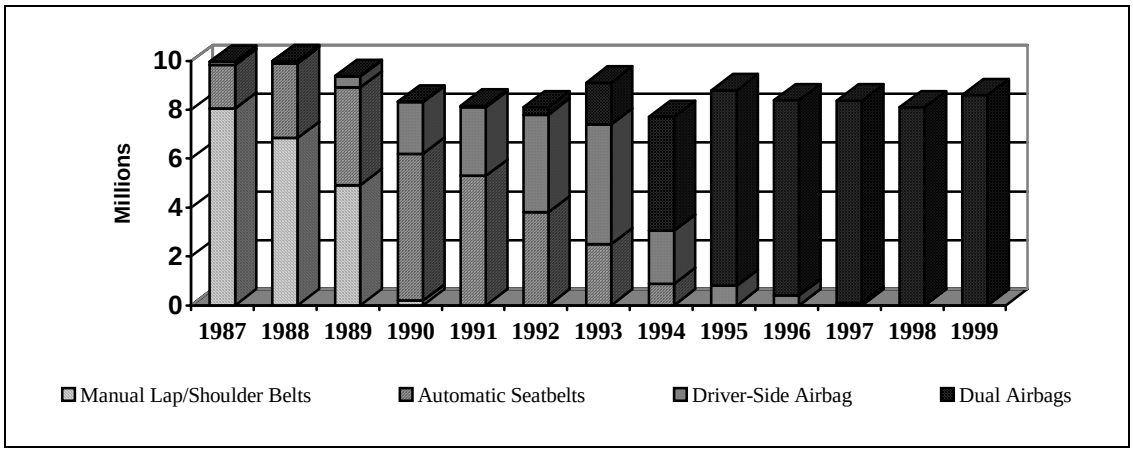
> *At least 95 percent of each manufacturer's passenger cars manufactured on or after September 1, 1996 and before September 1, 1997 must be equipped with an air bag and a manual lap/shoulder belt at both the driver's and right front passenger's seating position. Every passenger car manufactured on or after September 1, 1997 must be so equipped.*
>
> *At least 80 percent of each manufacturer's light trucks manufactured on or after September 1, 1997 and before September 1, 1998 must be equipped with an air bag and a manual lap/shoulder belt. Manufacturers may count towards compliance with the 80 percent requirement those light trucks it produces that are equipped with an air bag and manual lap/shoulder belt at the driver's position and a dynamically-tested manual lap/shoulder belt at the right front passenger's position.*
>
> *Every light truck manufactured on or after September 1, 1998 must be equipped with an air bag and a manual lap/shoulder belt at both the driver's and right front passenger's seating positions. Multistage light trucks are required to comply with the same requirements that apply to comparable single stage light trucks.*[5]

The twenty-year debate came to a close with this act of Congress. Indeed, the widespread introduction of airbags was virtually a foregone conclusion at this point due to the rising acceptance of airbags in the marketplace.

2.2 PENETRATION RATES FOR AIRBAGS

In 1984 Mercedes-Benz was the first automaker to offer optional airbags on passenger cars since GM's brief and ultimately unsuccessful flirtation with the airbag during the 1974-76 model years. Other automakers adopted a wait-and-see approach to airbags due to uncertainty over how consumers would respond to the safety devices. Figure 2-1 displays the automaker incorporation of passive restraint technologies in cars (excluding light duty trucks).

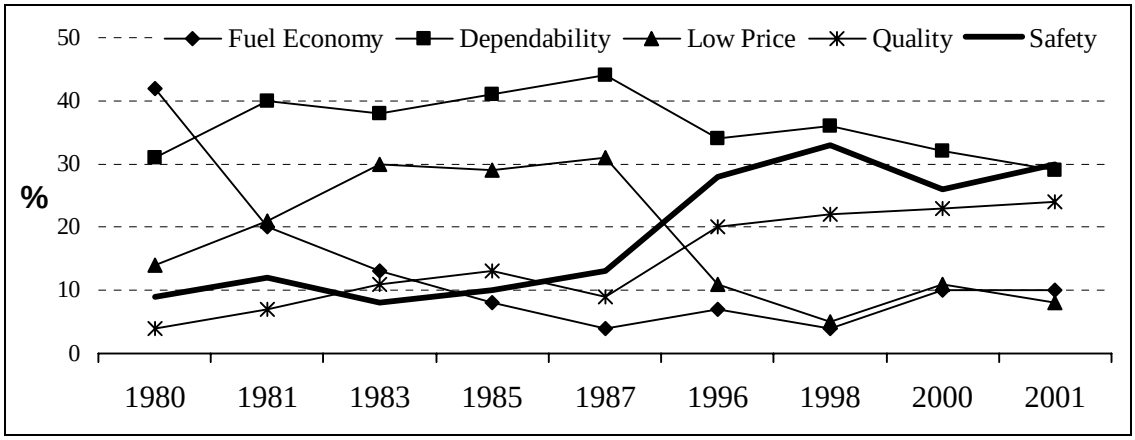
Figure 2-1 Annual U.S. New Passenger Car Sales by Occupant Restraint System



Source: Ward's Automotive Yearbook, Automotive News Market Databook – Various Years

By the 1990 model year, a full-fledged airbag race had emerged. The Big Three Detroit automakers quickly ramped up production – from selling a little over 400,000 airbag-equipped vehicles in 1989 to nearly two million in 1990. Chrysler, and to a lesser extent Ford, provided much of the impetus behind the move toward airbags. GM followed its two smaller rivals. GM President Robert Stempel expressed concern over the cost of airbags and how these costs would be passed on to the customer, along with the yet unproven consumer acceptance of the safety devices.[6] European automakers, who tended to sell more high-end cars in the US market, were also well out in front with airbags. Asian automakers, except for luxury models, had taken the less expensive path and embraced automatic seat belts instead of airbags. It has been hypothesized that the domestic automakers adopted the technology relatively quickly in 1990 because the American firms saw it as a way to positively differentiate themselves from Japanese automakers.[7] The Japanese soon responded. During the 1990 model year, domestic automakers offered airbags in one-third of their cars sold in the U.S., while Japanese manufacturers had them in only 6% of their vehicles. In the 1992 model year 54% of Japanese cars sold in US had airbags compared to 49.5% of U.S. cars.[8]

Figure 2-2 History of Consumer Valuation of Vehicle Attributes



Sources: For 1980s: J. D. Power (data based on new car buyers). For 1996+: Opinion Research Corporation International (ORCI) for National Renewable Energy Laboratory (NREL), Studies # 707089, 709318, & 710288.

As previously mentioned, the race to install airbags was to a great extent forced by regulation, but a shift in car buyer's valuations of vehicle attributes was also an important motivation. Figure 2-2 illustrates the ascendancy of safety concerns from the 1980s when it was the most highly valued attribute for less than ten percent of consumers, to the 1990s when it was rated number one by roughly one-third of the consumers polled. The arrows of causation for the rapid introduction of airbags and the dramatic rise in concern for vehicle safety went both ways. Airbags benefited from consumers new found awareness of safety. By the early 1990s, airbags even became a metric of vehicle safety. The presence of airbags in vehicles, dealer's showrooms, and the media, heightened the car shopper's interest in safety.

Figure 2-3 Driver-Side Airbag Installation Rates in US Passenger Cars by Automaker Region

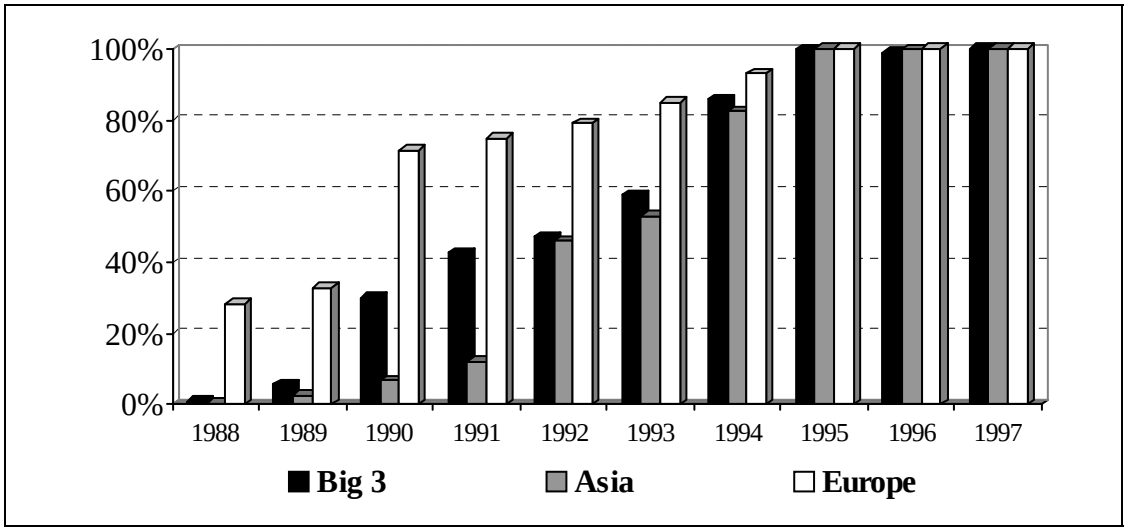
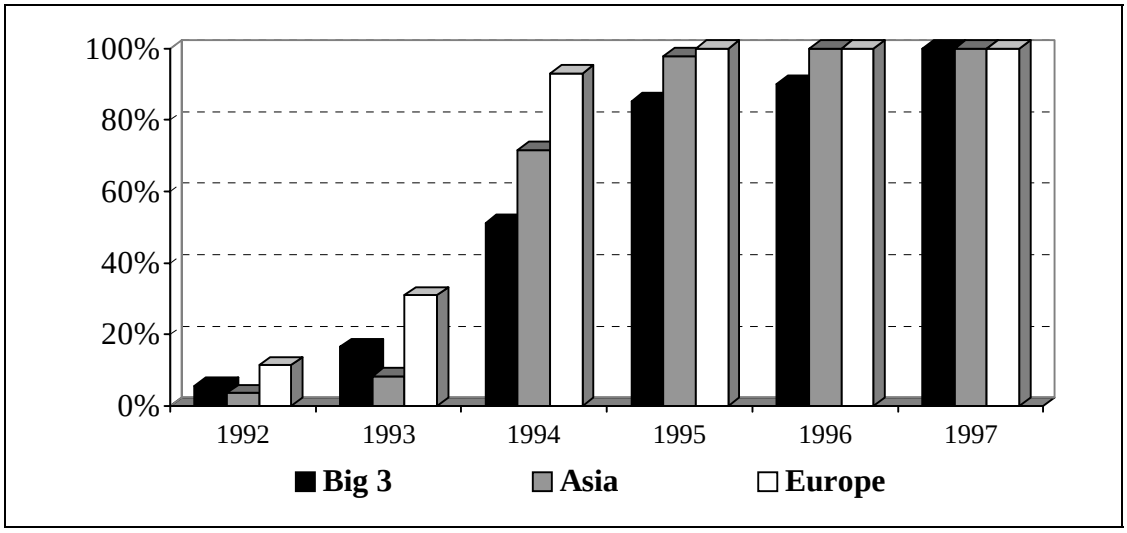


Figure Notes: 1**. Big 3** is GM, Ford, and Chrysler 2. **Asia** is Toyota Group, Honda Group, Nissan Group, Mazda, Subaru, Mitsubishi,. and Hyundai 3. **Europe** consists of Volkswagen, Audi, Mercedes-Benz, BMW, Volvo, and Saab. **Source:** Ward's Automotive Yearbook (Various Years)

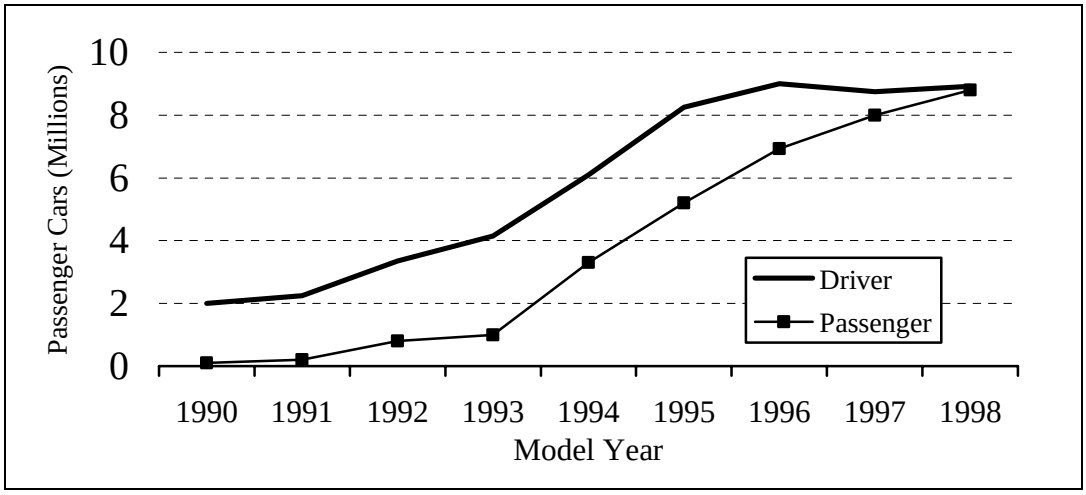
Figure 2-4 Passenger-Side Airbag Installation Rates in US Passenger Cars by Automaker Region



Source: Ward's Automotive Yearbook (Various Years)

Figures 2-3, 2-4, and 2-5 show in greater detail the installation rates of driver and passenger airbags over the time period of interest. Automakers responded quickly to the regulation, particularly in the case of passenger airbags. Due to the flexibility of the phase-in schedule, automakers were able to introduce the safety devices into their vehicle lines in ways that made the most sense for each automaker.

Figure 2-5 Number of Airbag Units Installed on Passenger Cars Sold in the US



Source: Ward's Automotive Yearbook (Various Years)

3 INDUSTRY RESPONSE

The prospective regulation of airbags became a heated debate that pitted automakers and their sympathizers on one side, and the NHTSA, insurance companies and various safety proponent groups and individuals on the other. One of the recurring and most successful arguments put forth against the adoption of airbag regulation concerned the added cost that would be incurred by the automobile manufacturers, and the inability of the market to support that cost. Automakers claimed that NHTSA offered highly optimistic, and in some cases, unrealistic cost estimates for the airbag system. Meanwhile, government and safety proponents argued that carmakers inflated the true cost of the systems in order to strengthen their case against airbags. Complicating matters was the variability in airbag system complexity and modular construction among the various carmakers and automotive suppliers. Varying amortization schedules and projected production volumes added yet more layers of complication.

Here we compile, interpret and present the wide range of cost estimates that were presented in the media, Congressional hearings, and other documents. Retrospectively, we analyze the added cost of airbags to manufacturers and buyers, and explore whether this cost differential was markedly dissimilar to typical annual changes in vehicle prices. As part of this analysis, we estimate experience (cost) curves for airbags and airbag components. We also look at automotive safety technologies that were not regulated, specifically anti-lock braking systems (ABS), traction control, and side airbags.

3.1 Barriers to Airbag Adoption from an Automaker Perspective

There were a number of obstacles that conspired against the swift adoption of a passive restraint standard. This explains the drawn-out character of the passive restraint regulation.

3.1.1 Cost

Cost is a central theme in this report just as it was in the drawn-out debate over passive restraint regulation. Issues dealing with cost and pricing will be addressed at great length later in this section. The automakers' argument based on cost stemmed from other arguments that could be made against airbags. If airbags were a considerably more expensive possibility for meeting the passive restraint standard, then automakers would choose the lower cost option, which in turn would make any airbags that were introduced more costly. This circular relationship provided a strong case against airbags. NHTSA could have eliminated much of the cost argument by mandating airbags exclusively. The large cost associated with replacing a deployed airbag was also a deterrent. Questions were raised whether a car may have to be declared totally destroyed in a minor collision because the replacement cost of the airbag is higher than the car's value.[9] Auto insurers were universally in favor of airbags, which indicates insurance plans would address these and other concerns.

3.1.2 Product Liability Claims

The legal complexities rooted in the liability concerns of automakers are beyond the scope of this report. A number of lawsuits were filed, particularly after 1990, involving accidents resulting in severe injury or death where the vehicle was not equipped with an airbag. These lawsuits claimed that automakers possessed both airbag technology and the knowledge of its life-saving potential, but chose not to install the technology. These so-called 'no-airbag' lawsuits resulted in settlements in many lower courts, but were not upheld upon appeal when the Supreme Court settled the issue in 2000. Such liability claims were a concern to automakers, but greater concern was given to product liability claims stemming from a possible inadvertent deployment, failed deployment, or injurious deployment in a moderate collision.

3.1.3 Less Expensive Alternatives

As described above, automakers were granted flexibility when complying with the passive restraint standard. Experience from the first (and failed) attempt at a passive restraint standard during the early 1970s may have helped inform the more successful regulatory process that came in the following decade. In 1970 Ford Motor Company petitioned the National Highway Safety Bureau (NHSB), predecessor agency to NHTSA, to allow ignition interlock devices, which would prevent the vehicle from being started unless the seatbelt were fastened, in lieu of airbags. Ford argued that seat belt usage could be bumped up to acceptable levels if "a more sophisticated ignition interlock system, exterior warning device, etc., [could] be developed."[10] An interlock system on all new vehicles for the 1974 model year was included in the pending regulation, but once the technology appeared in cars, consumers flatly rejected it, often by disconnecting the

wires, rendering the system ineffective. The House of Representatives soon voted by a large margin to render the regulation requiring the device (or airbags) null and void.[11]

The history of automatic seatbelts during the late 1980s and early 1990s was similar to that of the interlock device. The unpopularity and awkward functionality of the automatic seat belt may have benefited airbags. For some consumers the impetus behind purchasing an airbag-equipped car may not have been, "I want an airbag," but rather, "I don't want automatic seat belts." But it was becoming apparent that the industry was moving toward airbags and away from the unpopular belts. Automatic seat belts were also considered dangerous because occupants could be lulled into a false sense of security and fail to buckle their lap belt thus making the safety system potentially more dangerous than no seat belt at all. As a result, it was reported in mid-1991 that automakers would phase out the automatic belts over the course of the next few years prompting the president of the Insurance Institute of Highway Safety (IIHS) to say, "in a few years automatic seat belts are going to be like dinosaurs."[12] The head of NHTSA since 1989, Jerry Curry, acknowledged in August 1991 that with the information on crashes that was then available, airbags combined with seatbelts should have been mandated exclusively.[13] The timing of this recognition of regulatory failure, which pointed out the inferiority of automatic seatbelts, was curious because the belts were still being installed in the millions despite the broad aversion consumers developed toward the intrusive devices. The automatic seatbelts were quickly becoming the bête-noir of passive restraint options, while airbags were being met with unexpected acceptance.

Standard 208, which includes occupant crash protection, was written to be a performance-based regulation that would not specify one particular technology in a mandate. This loophole left open the opportunity for automakers to seek out and develop alternative passive restraint technologies that would meet the crash test criteria at a lower cost than airbags. The automakers indeed did develop two competing technologies, ignition interlock and automatic seat belts, but they were inferior to airbags, according to crash tests, and provided no added protection above and beyond a lap and shoulder belt. Instead, the ignition interlock and automatic safety belts would in theory simply force the occupant to wear this pre-existing protection. Consumers ultimately and emphatically rejected the entire premise these safety devices were based upon. As a result, it ended up being a more costly and circuitous road to equipping cars with airbags than it may otherwise have been if the regulations were more strongly written and implemented, and if carmakers were more cooperative. Both the policymakers and the auto industry made the pathway to airbags more circuitous than was necessary.

A possible alternative to a passive restraint standard altogether was a seatbelt law. Passive restraints were deemed necessary in the first place because of the low usage rate of existing seatbelt systems. One irony is that airbags are truly effective only if seatbelts are also worn. Another irony is that automakers opposed regulation that would make seatbelts mandatory because it would ruin the styling of their vehicles and reduce sales.[14] Automakers pushed for a regulation that would provoke behavioral changes, namely 'buckling up', while NHTSA regulators and their supporters insisted that passive restraints were also needed. As of today, we have both types of laws. Dual airbags are of course mandatory on all new vehicles sold in the U.S., and 49 states have mandatory seatbelt use laws, 18 of which are *primary* laws allowing police to treat a seatbelt violation as a standard traffic violation.[15] A spokesperson for Ford Motor Co.

articulated the position of the auto industry on the matter at the time: "the decision to force the substitution of unproven "automatic protection" devices for proven, reliable, and effective active safety restraint systems is so fraught with error as to be both lacking in rational basis and unsupported by substantial evidence in the rulemaking record."[16] Automakers as a sign of solidarity banded together to support seatbelt usage laws and informational campaigns to construct a meaningful alternative to passive restraints.

3.1.4 Questions about Airbag Reliability and Performance

Airbags are unique among automotive systems. Brakes, for example, can be disassembled for inspection or maintenance, and can provide the driver feedback regarding their condition when the brakes are used. Airbag systems may remain unused for long periods of time, but must effectively deploy in milliseconds when a frontal crash occurs. The fears surrounding airbags during the regulatory debate were not only that the airbag would not deploy properly in the event of a crash, but also that it may deploy unnecessarily during normal driving conditions. Despite the successful de facto field tests done by State Farm and the owners of airbag-equipped GM cars, questions concerning the reliability of airbags across an entire fleet of vehicles continued to be raised.

3.1.5 Airbag Regulation was viewed as Beatable by Automakers

Of the three main automotive regulatory initiatives at the time – fuel economy, emissions, and safety – the airbag may have been viewed as the least tenable. While all of these potential regulations were perceived as imposing significant cost, airbags had a number of other strong arguments against them. Product liability concerns, uncertainty about replacement costs, and lobbying for reasonable alternatives all worked against a speedy adoption of an airbag standard. On a more fundamental level, the nature of performance standards created problems in the safety area that were absent from fuel economy or emissions. Any flexibility created for emissions and CAFE standards did not impair the chances of a preferred technology as in the airbag case. The following passage helps explain why automakers chose to fight aggressively against NHTSA.

> *They (automakers) wanted relief from environmental requirements too, but they knew that was impossible. They had already talked to William Ruckelshaus at the Environmental Protection Agency (EPA) and had been given a lesson in statutorily mandated regulation. The Congress had put EPA emission control criteria under a strict statutory timetable that neither agency nor industry could evade for long. Under that statute manufacturers might get a year's relief, but only if they could demonstrate their own failure in good faith effort at compliance.*[1]

Once automakers were granted a significant delay in meeting the passive restraint regulation the first time, the difficulty NHTSA experienced in enacting the regulation intensified.

3.2 COMPLIANCE COST

3.2.1 Reported Airbag Cost Estimates 1969 – 2000

A large number of airbag cost estimates were produced during and after the time of deliberation. Most of these were conducted before airbags were mass produced. All suffer some shortcoming, often related to the interests of the sponsor or analyst. The studies are confounded by asymmetric information. Industry groups that face potential regulation generally have better information about the nature of compliance strategies than regulatory agencies and advocacy groups. Industry cost estimates are often susceptible to being too high, especially when firms do not fully anticipate cost-saving measures they may discover once company efforts are directed toward compliance. Indeed, regulation can trigger innovation that can offset some or all of the compliance costs.[17] When companies are opposed to regulations, they will tend to be pessimistic about cost improvements.

Similarly, government and safety advocacy groups tend to be optimistic about cost improvements. Whether the bias in the opposite direction is equal in magnitude is unclear. NHTSA did forecast the future costs of airbags with a reasonable degree of accuracy, and tended to overestimate the benefits of airbags (i.e. lives saved and injuries reduced) to a greater extent than the cost reductions of airbags. At least one study argues that government agencies tend to overestimate compliance costs more often than they undervalue these costs.[18] This study states that most regulatory cost estimates ignore the possibility of technological innovation mainly because it is difficult to predict. Technical change tends to defy accurate forecasting, and based on historical experience, the only thing that is certain is the cost of compliance will likely decline, but at what rate is anybody's guess. NHTSA employed thorough analyses based on available data to arrive at reasonable forecasts that were more or less validated by what eventually transpired.

This airbag case study does uncover some discrepancies in cost estimation over the years and across the government and industry groups. NHTSA relied on cost information from airbag suppliers and from its own teardown studies, which lead to fairly reliable results. The complexity in estimating the costs of airbag technology is due to the large economies achieved with mass versus limited production, and the progress achieved in reducing the cost of airbag inflators and other components once a market was assured by regulation. Despite these uncertainties, NHTSA made reasonably accurate cost estimates, as did the industry given their tendency to use unfavorable assumptions of production volume and amortization schedules. Once passive restraint regulation became an airbag mandate, the cost estimation process was simplified considerably because Congress made the regulation a design standard by requiring airbag technology to be the sole compliance strategy. The economic complications associated with predicting firm-by-firm compliance with a performance standard were thereby removed, though the flexibility benefits of a performance standard were also removed. If policymakers had insisted on airbag technology as the only suitable means to meet the standard from the beginning, both cost estimates and actual costs would have been lower due to higher production runs, a steeper learning curve, and a higher concentration of innovative energy that focused exclusively on airbag technology. In many instances a performance standard

leads to the optimal means of compliance, but in the case of airbags, a performance standard allowed automakers to explore avenues of compliance that were later found out to be unacceptable, or poor substitutes for airbag technology.

Post-regulation history has validated both the approach NHTSA took and the estimates the agency generated. Aside from the furor that arose in response to inadvertent deaths mostly of smaller women, children and infants caused by airbag deployment in low-speed crashes, the seven year or so transition to a 100% airbag-equipped vehicle fleet went off without a hitch. In retrospect, the cost estimates generated by government, airbag supplier and insurance sources have been shown to be more accurate and realistic than OEM projections. Table 3-1 summarizes the wide range of estimates that appeared between 1976 and 1982 when the debate surrounding airbags and passive restraints raged most intensely. The estimates produced by John DeLorean, a GM Executive turned private consultant, were formulated using GM's typical cost-figuring method.[19] DeLorean argued that GM was using an unusual method for determining cost because the company was opposed to the regulation. DeLorean's 1976 estimate range of $241-$298 in 2002 dollars was in line with DOT estimates and was lower than some pro-regulation insurance industry sources (e.g. AIA and Nationwide) at the time. As shown in Table 3-2, the markup to arrive at consumer cost is between 2.6 and 2.8 times manufacturer cost for Ford and GM systems. These results were made public from confidential sources by the Center for Auto Safety. The great disparity between costs associated with low and high production volumes can be seen in Table 3-1. Low production volumes were allowed to be considered for automakers such as GM and Ford that sold well over a million vehicles per year because any pending passive restraint regulation could be met by the much less expensive option of automatic seatbelts. This led to consumer cost estimates well in excess of $1,000 (2002 $) for a driver side airbag. If the regulation called exclusively for airbags, high production runs would be implicitly built into the assumptions behind the cost formulation. Moreover, since airbag suppliers would be providing airbag systems in large quantities, the smaller OEMs would benefit from the large price reductions that would result from the large economies of scale.

Table 3-1 Reported Non- Proprietary Airbag Consumer Price Estimates

Year	Source of Estimation	Production Run (if specified)	Airbag Price Estimate ($1982)	Airbag Price Estimate ($2002)
1976	Chrysler		$449	$800
	Ford		$431	$768
	GM		$329	$586
	DeLorean1		$167	$298
	AMC		$449	$800
	Toyota		$644	$1,148
	Amer. Insur. Assoc.		$374	$667
	Nationwide Insurance		$192	$342
	Allstate		$150	$267
	DOT1		$186	$332
	DeLorean2		$135	$241
	DOT2		$150	$267
	DOT3		$145	$258
1977 78	GM	3.5 Million	$273	$487
	Ford		$332	$592
	DOT		$158	$282
	Chrysler		$368	$656
	Ford (Letter 1979)		$353	$629
	NHTSA (Letter 1979)		$263	$469
	BMW		$1,040	$1,854
	Ford		$832	$1,483
	NHTSA (Jaguar)		$416 - $1144	$742 - $2039
	Chrysler		$1,040	$1,854
	Renault		15 – 20% Car Price	- - - - -
1981	GM	100,000	$1,144	$2,039
	DOT1	1 Million	$196	$349
	DOT2	1 Million (Dual)	$343	$611
	Talley1	10,000 (3 airbags)	$1,247	$2,223
	Talley2	500,000	$291	$519
	GM	400,000	$676 - $728	$1,205 - $1,298
	Ford	200,000	$858	$1,529
	Talley & NHTSA	100% installation	$208 - $312	$371 - $556
	Talley3	2 Million	$220	$392
	Center for Auto Safety		$208	$371
1982	Ford (U.S. GAO)	Near 100% Install	$235	$419
	Ford (U.S. GAO)	787,000	$575	$1,025
	Ford (U.S. GAO)	200,000	$828	$1,476
	NHTSA (U.S. GAO)	Near 100% Install	$112	$200
	GM (U.S. GAO)	Near 100% Install	$193	$344
	GM (U.S. GAO)	750,000	$509	$907
	GM (U.S. GAO)	400,000	$581	$1,036
	Automobile Occupant Protection Association (AOPA)	10,000	$1,100	$1,958
	AOPA	100,000	$500	$890
	AOPA	500,000	$280	$498
	AOPA	1,000,000	$240	$427
	AOPA	2,000,000	$185	$329
	Average Auto Industry		**$579**	**$1,032**
	Average NHTSA, Insurance,	**Etc…**	**$266**	**$474**

Source: All Sources Listed in the Bibliography of Data Sources

In Table 3-2 a number of cost estimates generated by GM and Ford are presented. The consumer cost indicates the retail price of an installed airbag system, while the manufacturer's cost is the cost incurred by the automakers for one complete airbag system based upon a specified production volume. The manufacturer's cost was confidential before Clarence Ditlow of Center for Auto Safety released the internal DOT memorandum to the press in 1979. The markup method used to arrive at the consumer cost is not specified, but is higher than typical markup factors. For example, NHTSA uses a typical markup factor of (1.33*1.51), or about 2, in its teardown studies. In 1982, GM sold 3,491,630 passenger cars in the U.S., and Ford Motor Co. sold 1,345,970 cars. GM and Ford had high enough production volumes to achieve the much lower costs reported in Table 3-2.

Table 3-2 NHTSA Estimate of Airbag Costs

System	Volume	Estimator	Date	Consumer Cost	Manuf. Cost	Ratio Consum. Cost to Manuf. Economics
GM 82	400,000	GM	3/79	$581	***$221***	2.6 (1979)
GM 82	750,000	GM	3/79	$509	***$195***	2.6 (1979)
Ford 82	885,000	Ford	8/78	$268	***$101***	2.7 (1976)
Ford 82	787,000	Ford	7/79	$575	***$213***	2.7 (1982)
Ford 82	200,000	Ford	7/79	$825	***$300***	2.8 (1982)
GM 80's	3,500,000	GM	11/78	***$206***	***$96***	2.1 (1982)
GM 73 Buick	100,000	DeLorean	10/78	$192	NA	NA

Source: Internal DOT Memo, Subject: Outrageous Air Bag Costs. From Director of Office of Vehicle Safety Standards, A.C. Malliaris to Associate Administrator for Rulemaking, Michael Finkelstein, 11 July 1979. Received from Clarence Ditlow, Center for Auto Safety, September 2003.

Table 3-3 Consumer Costs (RPEs) of Airbag Systems from Three NHTSA Contracted Studies

YEAR	VEHICLE	PRODUCTION RUN	AIRBAG PRICE ESTIMATE (CURRENT $)	AIRBAG PRICE ESTIMATE (2002 $)
Khadilka[20] (1988)	Mercedes 190E[1]	150,000	$443	$670
	Mercedes 190E[1]	350,000	$325	$492
	Mercedes 190E[2]	350,000	$352	$533
	Mercedes 190E[3]	350,000	$380	$575
	Ford Tempo[1]	25,000	$815	$1,233
	Ford Tempo[1]	350,000	$258	$390
	Ford Tempo[2]	350,000	$286	$433
	Ford Tempo[3]	350,000	$308	$466
Fladmark, et al.[21] (1992)	Ford Crown Victoria[4]	300,000	$332	$417
	Acura Legend[4]	300,000	$486	$610
	Toyota Camry[1]	300,000	$308	$387
	Buick Roadmaster[1]	300,000	$307	$385
	Plymouth Acclaim[1]	300,000	$226	$284
	Chevrolet Camaro[1]	300,000	$278	$349
Spinney, et al.[22] (2000)	Chrysler Cirrus/Stratus	250,000	$354	$370
	BMW 5-Series[5]	250,000	$730	$763
	BMW Z3	250,000	$362	$378
	Ford Taurus	250,000	$372	$389

1 – Driver-Side Airbag (No Auto Seatbelts) 2 – Driver-Side Airbag w/ Auto Seatbelts
3 – Dual Airbags w/ Auto Seatbelts 4 – All are dual airbag systems + seatbelts 5 – System includes Side Airbags and Head/Curtain Airbags

Table 3-3 summarizes the cost estimates derived from three DOT contracted teardown studies that use NHTSA's standard methodology. The considerations taken are outlined in Appendix F. The Ford Tempo and Mercedes 190E estimates show costs at two different production runs. The retail price estimate of the airbag system for a Tempo

produced at 350,000 units is less than one-third of the price when only 25,000 units are produced. The economies of scale for the 190E are not as great, presumably because much of the scale effect had already been achieved at 150,000 units. A standard cost-cutting measure of automakers involves optimizing production overlap and benefiting from economies of scale in their operations. A detailed discussion deriving from the cost estimates shown in Table 3-3 will be offered in section 3.3.1.

3.2.2 Option Pricing of Airbags

Once airbag installation really took off around 1990, the safety devices were almost exclusively offered as standard features. Also as the passive restraint regulation segued into an airbag mandate during the same time period, automakers felt a sense of urgency to introduce airbags into their entire lineup of cars as quickly as possible. Consumer demand also accelerated rapidly at the same time further fueling the airbag race. Analyzing how automakers priced the airbag as an option will help to paint a complete cost picture, even though airbags were offered only selectively as options. Anti-lock braking systems (ABS) were by comparison presented more as optional equipment because there was no mandate forcing the component's installation. The option pricing of airbags also tended to be well above cost because airbags were fast becoming a desirable attribute.

GM was far in front of the competition when it first offered optional dual airbags on a number of its full-size models during model years 1974 and 1976. GM offered the airbag option on a number of Cadillacs, Oldsmobiles and Buicks. During the three years, the company sold a little over 10,000 of these airbag-equipped cars, although the company had tooled up to produce in excess of 100,000 such vehicles, and had initially expected sales of 300,000 or more.[23] The dealers partly blamed the $225 to $315 price tag for the poor sales of the safety option as being prohibitively expensive for most car buyers. John Delorean, a GM executive turned private consultant argued that if GM had employed its typical cost-figuring method, the airbag option would have been priced at about $100.[19] Of course, at the small number of airbags that were actually produced, GM was selling each option at a substantial loss. The failure of regulators to enact a passive restraint standard that would support GM's attempts at introducing airbags into its vehicles, which at the time comprised 40% of the overall market, contributed significantly to the collapse of the GM airbag program. Regulators sent and continued to send mixed signals to the automakers, and set in motion a tendency toward stagnating compromise and delay that continued until airbag regulation was finally passed. On the other hand, GM abandoned the program quickly and did not get behind it with its full marketing muscle. These issues will be examined in a further section that explores the marketing of the airbag and safety.

Volvo publicized that it would offer driver-side airbags as an option on some of its 1983 model year cars, but the plan to do so never materialized. The retail price for these systems was expected to be $900 to $1000 per car.[24] Apparently undaunted by GM's rather disastrous attempt at selling the airbag, Mercedes-Benz announced in January 1983 that the company would offer optional driver-side airbags at an additional price of $800 to $900 per car on some of its 1984 models.[25] As described earlier, a number of observers that had followed the airbag regulation closely were sharply critical of the way GM marketed the airbag as an option in the mid-1970s. Perhaps learning from

GM's experience, Mercedes made the airbag a focal point of the company's safety-oriented advertising campaign. By 1989, it was reported that Mercedes was making money on its airbag system, which at that point had become standard on all of the company's models sold in the U.S.[26]

Ford Motor Co. was the next auto company to take the airbag plunge, in the 1987 model year. Interestingly, Ford offered an optional driver-side airbag on one of its least expensive models – the Tempo and its sister model, the Mercury Topaz. The price of the airbag alone was between $622 and $815, but the safety device was also included in two of Ford's preferred optional equipment packages at a cost of about $300. The airbag was grouped with other options, namely automatic transaxle and air conditioning for a total package price of $984 and $1013.[27] Ford sold between 10,000 and 12,000 airbag-equipped Tempos and Topazes during their inaugural year, but the company interpreted this as a positive because the option was introduced mid-season with absolutely no advertising support.[28] It was also reported that the company was losing money even at an $815 price tag.

During the airbag race that ensued in the late 1980s and early 1990s, GM lagged behind Chrysler and Ford, but it did begin to offer optional driver-side airbags on its 1988 model year Oldsmobile Eighty-Eights and 1989 Ninety-Eights and Cadillac DeVilles. GM priced the option alone at $850, but also included it in an option package like Ford did with the Tempo where the net price of the airbag was $300.[29] Unlike the Ford assemblage of options, GM gave a $500 rebate directly to the consumer for purchasing one of the option packages including an airbag. One of the option packages included 15-inch aluminum wheels and automatic air conditioning, while the other included a high-end stereo and tape deck. An internal debate surfaced inside GM during this time as to whether lower-priced cars should offer optional airbags. The unofficial company position was that these models (e.g. Pontiac Grand Am and Buick Skylark) were too price-sensitive to carry the burden of added airbag costs.[28] Higher-priced cars, all-new models, and those getting major design and engineering revamping were thus designated as the top priority vehicles to receive airbags. The engineering and manufacturing people at GM leaned toward making airbags standard equipment because of the up-front engineering and manufacturing work necessary to make modifications in order to install the airbag system in the vehicle.

The Chrysler Corporation saw a completely different prospect for the airbag. First of all, Chrysler intended to forgo option packages and introduce airbags as standard equipment on its cars. Albert J. Slechter, the company's director of federal government affairs, explained: "The concept of an optional system tends to lose significance when you must have passive restraints in all vehicles. The idea of an optional system, certainly in passenger cars at this time, loses meaning. They'll be standard equipment as we move toward 100 percent."[28] Chrysler chose to install airbags in large cars and sporty cars first because it is less difficult to implement a driver airbag on a larger vehicle than a smaller one, and sporty cars were considered "appropriate" vehicles for the safety device. Chrysler fully expected that with the volumes being predicted for airbags, prices would come down and be "totally competitive in the marketplace." Slechter predicted: "As airbag volume rises over the years, there's a tendency for costs to be lower, because you're going to be amortizing development costs through that time frame."

Nissan Motor Co. offered optional driver airbags on its 1991 model year 300ZX and 1992 Maxima for $500, and on its 1993 and 1994 Sentra and NX for $575. Subaru made airbags optional on its 1992 Legacy for $800. GM offered optional airbags on the company's 1992 Saturn division cars for $625.

The emerging market for airbags in England is interesting to consider because there was no regulatory driver pushing the adoption of airbags along. The market in England, unlike Canada, is not dominated by American automakers, which allows for a better comparison. BMW announced it would offer airbags as optional equipment on all of its cars sold in Great Britain in 1992. The cost to the consumer of this option was reported to be 745£ (~$1340).[30] Mercedes-Benz, as the acknowledged leader of the airbag race, had already been offering optional driver airbags. In October of 1991 it was reported that Mercedes had slashed the cost of the airbag option nearly in half from 1433£ (~$2579) to 750£ (~$1350) perhaps to compete with other luxury automakers now offering optional airbags, or possibly because the cost had come down sufficiently to justify such a drastic cutting of cost.[31] Mercedes also began offering standard airbags on the company's more expensive models to stay a step ahead of the competition. One of these competitors was Volvo, which was no stranger to innovations in auto safety. Volvo began offering optional airbags on its mid-sized 400 series cars during the 1992 model year for 730£ (~$1314).[32]

3.2.3 Airbag Component Costs

A number of components comprise an airbag system. The prices of these separate components thus comprise the total price of the airbag system. The quality and type of the components varies greatly across manufacturers and vehicle segments leading to a great deal of variability. For instance, many luxury models will include airbags made out of soft leather, and possess greater complexity in the electronic control systems.

The cost reduction of airbag systems has been dramatic. This large system reduction is attributable to uneven subsystem reductions. A prominent airbag supplier contacted for the purposes of this study estimates that the cost of a standard airbag module, comprised of the inflator, airbag itself, and cover, has fallen from over $200 to less than $50 over the last fifteen years.[33] According to the supplier representative, the cost reduction is attributable to the large increase in production volume as well as through improved technology, particularly of inflators. Table 3-4 highlights some of the costs of components that comprise an airbag system. This table differs from the information presented in Table 3-3, which included seatbelt costs for some of the models, and additional airbag (e.g. side airbag) cost for other models. It is important to note that the costs have consistently fallen, while the complexity, reliability, and safety of the airbag systems have all risen significantly. In other words, the cost of a circa 1988 airbag system in 2000 would be substantially lower than a circa 2000 system costs. As will be discussed in Section 3.6.2, there has been a proliferation in technological innovation related to airbags in the last 15 years. Such innovation has helped keep costs stable, while at the same time greatly improving the performance of the airbag systems.

Table 3-4 Airbag Component Cost Summary

Vehicle/Year	*Control Module*	*Sensor(s)*	*Wire Harnesses*	*Driver Airbag + Inflator Assembly*	*Passenger Airbag + Inflator Assembly*	*Clock Spring Assembly*	*Total*
Ford Motor Co. 1987*	$42.60	$48.43	$37.88	$172.59	N.A.	N.A.	$391.35
Mercedes-Benz 1987*	$67.88	$106.46	$64.42	$191.22	N.A.	N.A.	$493.24
Ford Crown Victoria 1992**	$35.99	$13.64	$26.99	$73.79	$129.30	$17.83	$380.36
Acura Legend 1992**	$172.25	$36.07	$37.85	$64.18	$117.08	$19.00	$560.81
Mercedes-Benz 1997**	$155.65	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Chrysler Cirrus-Stratus 1998**	$108.04	Incl. in ACM Cost	$9.77	$65.18	$109.78	$3.29	$317.78
BMW 5-Series 1998**	$159.47	Incl. in ACM Cost	$18.12	$58.35	$94.26	$4.06	$334.26
BMW Z3 1998**	$156.33	Incl. in ACM Cost	$17.45	$67.90	$110.50	$3.94	$361.50
Ford Taurus 2000**	$96.16	Incl. in ACM Cost	$0.00	$81.34	$103.45	$3.29	$313.93

Table Notes: All values are Retail Price Equivalents in $2000. Airbag systems do not include seatbelt cost, but do include knee bolster and other related restraint system cost. **Sources:** Khadilka, Fladmark et al., Spinney et al.

3.3 EVOLUTION OF COMPLIANCE COST

3.3.1 Cost Reductions of Airbag Systems

Arguments concerning airbag cost contributed greatly to the delay in implementing a passive restraint standard, but once a regulation was adopted; cost was not much of an issue. This was partly due to the large drop in airbag system costs. Much of this reduction was achieved through economies of scale and learning effects. Out of the roughly 10 million 1988 model year passenger cars sold in the U.S., about 220,000 contained a driver-side airbag, and greater than half of these were from luxury European makers. As marginal as the market was at the time, the U.S. did comprise the largest automotive airbag market in the world by a wide margin. Ten years later, every new passenger car sold in the U.S. and virtually all light trucks were equipped with dual frontal airbags. Clearly, the cost structure, as well as all other aspects of the industry, underwent profound changes during this period. At the same time, the quality, reliability and technology in general of the airbag systems was enhanced greatly as well. Comparing the cost of a 1988 and 2000 airbag system is hence an apples and oranges comparison, but the alternative of comparing what a 1988 system would cost in the year 2000 is also problematic because cost data is not available for that level of analysis. All of the costs discussed below are cost to consumers or retail price equivalents (RPE), which include all relevant markups, unless noted otherwise.

A teardown analysis that looked at the costs of airbags for the Mercedes-Benz and Ford Tempo systems respectively was conducted in 1988. This study determined that the cost for a Ford driver-side airbag was $391 at a production rate of 350,000 units and $1,233 at 25,000 units (2002$; See Figure 3-3).[20] The cost to Ford Motor Co. was considerably higher than $1,233 since the company sold only 13,471 airbag-equipped 1988 model year cars. Before lowering the price considerably due to lack of demand, Ford offered the airbags on MY1987 and 1988 Tempos and Topazes as an option for $815 ($1,233 in 2002$), and admitted to selling them at a loss.[28] By way of comparison, another teardown employing the same methodology (see Appendix F) found that a driver-side airbag on a 2000 Ford Taurus had a cost of about $180 at a production volume of 250,000 units.[22] This $180 figure also included the added cost due to some shared components with the passenger-side system. Unlike the 1988 cost estimates, the actual cost in this case was most likely lower than $180 per unit since Ford sold 382,035 MY2000 Ford Tauruses, and similar airbag systems were found on all of the company's nearly 1.7 million MY2000 passenger cars sold in the U.S., not to mention the company's nearly 2.5 million MY2000 light trucks sold in the U.S., all of which had a dual airbag system. Another teardown study conducted in 1992 examined the Ford Crown Victoria. The analysts determined the cost for the driver-side airbag system to be about $251 in 2002$ at a production rate of 300,000 units.[21] This estimate suggests that much of the eventual cost reduction had occurred in the first few years after airbags were introduced, and the rate tailed off considerably after large quantities of airbag systems were being produced. Ford Motor Co. sold roughly 707,000 MY1992 cars equipped with driver-side airbags and another 284,000 cars outfitted with dual airbags. The 1992 airbag systems resembled the 1987 systems more closely than those of 1998 and beyond. A trend analysis conducted by NHTSA compared 1990 and 1998 airbag systems, and found great

changes in airbag design, airbag placement, inflator type and pressure characteristics, and number, type, and placement of airbag controller sensors between the early and later systems.[34]

For the 1987 Mercedes-Benz system, the cost was estimated at $492 at a production volume of 350,000 and $670 when 150,000 units were produced (2002$; See Figure 3-3). In this case, the cost was also higher than $670 because only about ½ of the 150,000 airbags were sold annually in the U.S. around this time (77,945 for MY1988 and 78,840 for MY1989). Mercedes offered optional driver-side airbags for about $900 ($1,400 in 2002$) on its 1984-85 models.[35] By 1989, it was reported that Mercedes was making money on its airbag system, and that the safety device had been standard equipment on all of the company's models sold in the U.S. since MY1987.[26] Cost estimates for later Mercedes' airbag systems were unavailable, but the cost of a driver-side airbag on another luxury sedan – the 1992 Acura Legend – was estimated to be $444 in 2002$.[21] Acura sold nearly 66,000 dual airbag-equipped MY1992 cars in the U.S., and in 1989, 1990, and 1991 had sold 72,072, 57,133, and 61,321 cars respectively with driver-side airbags. So although Acura lacked the level of airbag experience Mercedes possessed, the subsidiary of Honda had been producing the safety systems at comparable volumes. A teardown study conducted in 2000 found that cost of two MY1998 BMWs driver-side airbag systems was $240 for the 5-series and $251 for the smaller Z3 at a production volume of 250,000 units. The system complexity of the BMW system is comparable to that of Mercedes, so comparing these figures with those generated in the 1987 study for Mercedes is reasonable.[36] Again the cost of airbag systems is shown to have fallen considerably, particularly over the first few years that airbags were introduced.

Improvements in certain areas of the airbag systems led to the most dramatic cost reductions. A representative for the airbag supplier, Takata, estimates that the producer cost of a standard airbag module, comprised of the inflator, airbag itself, and cover, has fallen from over $200 to less than $50 over the last fifteen years.[33] According to the supplier representative, the cost reduction is attributable to the large increase in production volume as well as through improved technology, particularly of inflators. Sensors have also contributed significantly to the price decline. A related air bag industry trend is the move toward silicon micro-machined accelerometers in a single-point configuration. These tiny sensors are cheaper than other types, and were estimated in 1992 to have a producer cost of about $5 to $6 each in large production volumes.[38] Similarly, Siemens Components Inc. developed an improved electronic sensor for airbag systems in 1994 that led to a manufacturing cost of $2.50 to $3.00 in volume.[39] Airbag systems in early years relied primarily on 3 or 4 electromechanical sensors (85% of systems in MY1990), while later systems typically use only one electronic sensor (50% of systems in MY1998).[34] In summary, large cost reductions were achievable due to a confluence of factors, particularly, technological innovation and learning effects, economies of scale, and pricing pressure from OEMs and an intensely competitive environment.

The effect of economies of scale on airbag components has been well documented. Table 3-5 highlights the expected cost reductions based upon escalating production runs generated by airbag supplier groups for a 1979 Congressional hearing. Even at this early date, the airbag suppliers exhibited a prophetic knowledge of the

Table 3-5 Expected Cost Reductions as a Function of Production Volume

Volume	Driver Bag + Inflator Module	Passenger Bag + Inflator Module	Sensors + Diagnostic Parts
13,000	Base	Base	Base
25,000	34 %	8 %	7 %
100,000	62 %	40 %	19 %
200,000	68 %	50 %	22 %
900,000	75 %	67 %	24 %

Source: Reference [40]

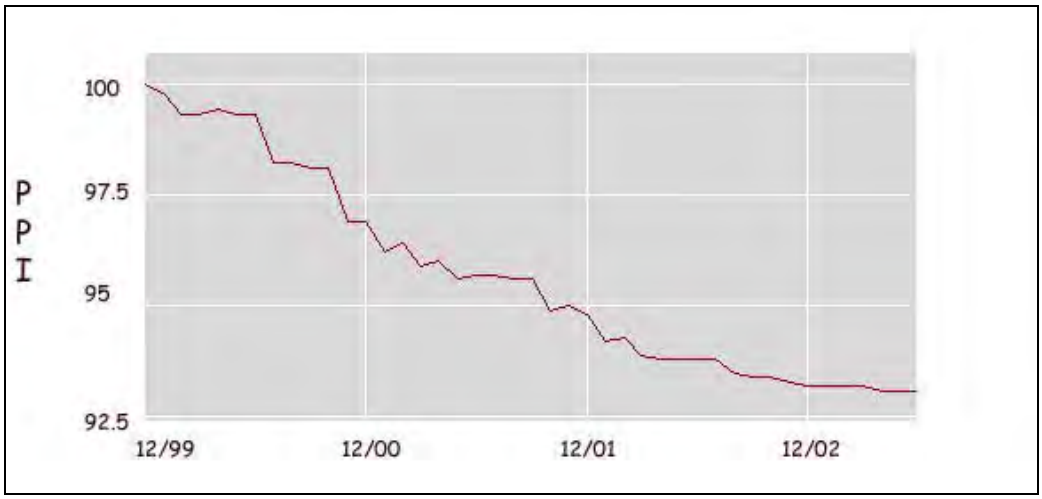
relationship between cost and volume. The retrospective analysis offered in the above paragraphs generally agrees with the prospective one given by the airbag suppliers.

These are exclusively production-level price effects, but when airbag production ramped up, the technology did not stand still. Airbags became more reliable and safer, while at the same time price came down. Although the reduction in price of airbag systems did not necessarily behave uniformly across time or production schedules, it can be argued that the quality-to-price ratio for airbags has steadily climbed from learning and production volume effects. The estimated economies of scale effects shown in Table 3-5 have been substantiated by the actual airbag component cost trends over time as shown in Table 3-4 and Figure 3-2.

3.3.2 Experience Curves for Airbag Systems

Figure 3-1 shows the trend in Producer Price Index (PPI) since the BLS started tracking airbag assemblies and parts data in December 1999. The PPI tracks the average change in net transaction prices that domestic producers receive for the products that they make and sell thus PPIs are output price indexes, not input cost indexes. The price quotations that the PPI uses to build these indexes come from a statistically chosen sample of representative transactions obtained from a representative sample of producers in each of the 600 or so industries for which PPI tracks data.[41]

Figure 3-1 Trend in Producer Price Index for Airbag Components



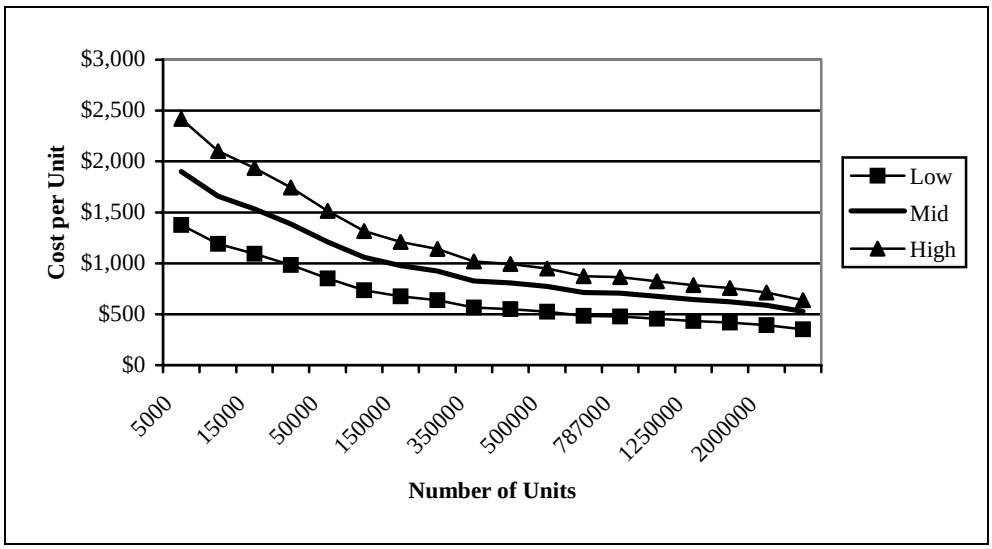
Source: Bureau of Labor Statistics, See: http://www.bls.gov/ppi/home.htm

The drop in PPI indicates that prices received by producers for finished airbag systems and modules fell about 8% in the three years or so it has been tracked. The curve also appears to have leveled off somewhat in the last 6 to 8 months. The fall in prices most likely has little to do with production rates since the airbag industry has been firmly established during this timeframe. Part of the price drop may be a response to tightening imposed by the automakers as the economy declined and profit margins shrank, but another explanation may involve a combination of the following:[42]

- Operator learning
- Improved methods, processes, tooling, machines and design improvements for increased productivity
- Management learning
- Debugging of engineering data
- Production rates
- Design of the assembly or part, or modifications
- Specification or design of the process

The reduction in cost of airbag systems over time is thus a confluence of these factors: the learning effects that accumulated as airbag suppliers and related companies formed an established, profitable industry, the rapid expansion of the industry that led to the well-documented economies of scales effects, and the innovation effects that helped to inform the design and management processes. These effects that both lowered cost and improved quality and performance are at least partially additive and are difficult to disentangle from one another. Figure 3-1 shows what is essentially a *de facto* experience curve, which captures this confluence of factors. Unfortunately, BLS only recently started tracking this PPI sub-index, so the curves for airbag components during the crucial period of 1988-2000 must be ascertained using another method.

Figure 3-2 Estimated Experience Curves for Dual Airbag System Cost



The learning curves in Figure 3-2 were estimated by performing a regression analysis using a power function, which has traditionally been the functional equation form when estimating learning effects. Due to the limited data points from which the equation was derived, the results should be used for illustration only. Table 3-6 shows the descriptive statistics from the analysis. The following equation is referred to as "Wright's Cumulative Average Model."[43]

$$\mathbf{Y = AX^b}$$

Y = cost per unit in constant 2002$
X = number of units
A = Cost for the first unit produced
b = slope of the function when plotted on log-log paper

Table 3-6 Results from Experience Curve Estimation for Airbag Consumer Cost

	Low Price	Mid Price	High Price
A	8,156 (3.87)	10,051 (3.84)	13,688 (3.25)
b	-0.2089 (-9.79)	-0.1956 (-9.11)	-0.2035 (-8.01)
R^2	0.85	0.83	0.79
Cumulative Production Cost 3,500,000 Units	$1,549,731,339	$2,295,008,094	$2,802,224,371
Average Production Cost 3,500,000 Units	$443	$656	$801

Notes: t-statistics in parentheses

Detailed cost information for airbag components and modules is difficult to gather. From a limited set of data points, a reasonably accurate set of experience curves can be developed for illustrative purposes. In this simple model, industry estimates would tend to follow the high price curve, while government estimates, as expected, would fall in the bottom range. Although the curves may seem close together the cumulative cost difference between high and low estimates is almost $1.3 billion.

3.3.3 Other Mechanisms that have Facilitated Cost Reductions

Airbag suppliers have been under tremendous pressure from automakers to keep finding ways to lower per unit costs. The extremely relatively low profit margins of the motor vehicle industry, along with the control that auto manufacturers exert upon suppliers, create a highly competitive market. This can be seen in figures in the following section where the CPI and PPI for the motor vehicle industry increase more slowly than average. The 2000 SEC 10k annual report for Autoliv, an airbag supplier that controls 29 percent of the global market, more than any other single supplier, sums up this phenomenon.

> As a consequence of the major automobile manufacturers' strong purchasing power, and the competitive pressures on car occupant restraint system suppliers to increase such suppliers' manufacturing capabilities, the unit prices of airbag systems and seat belts will continue to decline in the future. In addition, similar to other automobile component manufacturers, Autoliv expects that Autoliv and its subsidiaries will, under certain circumstances, quote fixed or maximum prices for long-term supply arrangements. The future profitability of Autoliv will depend upon, among other things, its ability to continue to reduce its per unit costs and maintain a cost structure, internally and with its suppliers, that will enable it to remain cost-competitive. Autoliv's profitability may also be influenced by its success in designing and marketing technological improvements in car occupant restraint systems.[44]

The above statement clearly outlines a major airbag supplier’s general strategy with respect to cost. Airbag suppliers, like most companies, must balance between effective cost-cutting strategies and continuing to produce a reliable quality product.

3.4 COMPLIANCE COST IMPACT ON VEHICLE PRICING

Many auto industry observers have contended that competition is the primary determinant of automobile pricing.[45] If this were true, it would not always make sense for automakers to pass on the costs of added equipment identically across their fleet of vehicles. Value pricing, popularized by GM with its launch of Saturn, is another strategy increasingly used by automakers. Also known as one-price selling, value pricing consists of a car with a fixed set of popular options and one usually nonnegotiable sticker price.[46] It was also reported in the same source that European manufacturers such as Mercedes-Benz and Saab have been cutting the cost of production, and effectively passing the savings on to the consumer by keeping price inflation to a minimum. The results of an economic analysis also suggest pricing behavior in the automobile market is consistent with theory governing price leaders and followers, as opposed to a mutually independent pricing rule.[47] This finding also contradicts to some degree the idea of perfect cost pass-through to the consumer. Given the extreme complexity of car pricing, and the often uncertain role that costs due to compliance play, documenting examples of how price changes have accompanied adjustments to vehicles will be helpful at reaching a fundamental understanding of the process.

Meanwhile, some auto industry analysts hold that carmakers are not able to fully recover the cost of regulated technologies, since these features are added uniformly across all vehicles disallowing for differentiation from competition.[48] The argument follows that OEMs can add the cost of new technologies to the sticker price, but because of over capacity and intense competition, it is difficult for automakers to recoup the cost directly and quickly. Innovations that differentiate the vehicle from the competition allow automakers to charge higher prices for some vehicles and in some segments of car buyers. In general, this only lasts for a few years by which time the new feature has already been integrated across many lines, or has been dropped due to small demand. The reality, though, is that pricing is part of a highly complex planning, manufacturing, and marketing process.

3.4.1 Compliance Strategies

Automakers utilize a number of pricing strategies to help mitigate the impact of compliance induced cost increases. The costs associated with emissions and safety regulations vary from small to significant. First and foremost, automakers seek to expand, or at least maintain, their market share. This can be jeopardized by the “sticker shock” that consumers will experience if prices are raised substantially in an across-the-board manner. For this reason, automakers recover compliance costs in a differentiated and disproportionate manner across their entire line of vehicles. Some of the strategies used by the auto manufacturers to maximize sales volume, while at the same time recouping compliance costs, will be presented in this section of the report and include the following.

- Automakers passed the costs incurred by regulation through vehicles that are in higher demand and/or have a higher profit margin. As will be shown in sections 3.4 and 4.1, and in Appendix A, the added cost of airbags is disproportionately passed on in more expensive vehicles, and to a lesser extent, better selling ones.
- If the technology is a future one, and is being introduced in a limited manner then only a portion of the full cost (including R&D) is reflected in the price of the

vehicle (e.g. vehicles would have been prohibitively expensive if the retail price truly reflected the high cost of airbags when the devices were first introduced, as with hybrid electric vehicles and a host of other new automotive technologies).

- Automakers may recoup the cost over the course of a number of years and number of models to avoid price shock. Clearly automakers must recoup cost much more often than not to remain profitable and viable. In the case of airbags, the regulation took this into consideration by allowing a gradual introduction of airbags across an auto manufacturer's vehicle lines.
- Offsetting reductions in standard equipment (decontenting) on some models may be used to mitigate the effects of cost pass-through pricing. There is some evidence of this with respect to airbags. For instance, GM recently decontented (i.e., eliminated) ABS and side airbags from some models as a cost-cutting measure.
- The impact of cost pass-through pricing may be tested by a series of minor price increases. This strategy is difficult to verify, but has been used by automakers to 'test the waters' and avoid 'price shock.'

Automakers also tighten their belts in other areas of their operation to maintain profit levels. These include the increased scrutinizing of non-regulatory project proposals and the exploitation of redundancies, scale economies, and other cost-cutting strategies in achieving compliance. Tooling, manufacturing, and materials management costs are also minimized through standardization techniques across differentiated product lines.[49]

3.4.2 Vehicle Pricing Policies of the Automobile Industry

Pricing policy is one of the most guarded decision-making practices of automakers. While an outsider could not document or accurately specify actual pricing decisions, a general understanding and characterization of pricing actions can be inferred from the literature and from the automakers' actions in the marketplace. Pricing is an integral component of automakers' managerial operations. For simplicity, price can be considered the point "where the value of the product to the customer and the company's compensation for producing the product intersect."[50] Pricing methods are based on an auto manufacturer's overall business strategy. The obvious primary objective of private firms is profit maximization. But in the auto industry with its highly differentiated product lines this does not necessarily translate to profit maximization strategy for each vehicle line in its portfolio. In addition, firms may adopt a sales volume objective, which has traditionally been GM's approach for expanding, or at least, maintaining market share. As the industry price leader, GM has traditionally been able to establish its own cost-based pricing that is denoted either by markup pricing or rate of return pricing.[51] GM has lost its ability to dominate automobile price setting as its market share has shrunk and foreign competitors such as Toyota and Honda have found ample territory aside from price in which to compete with GM. Competition-based pricing is another method automakers use when setting prices. In order to stay competitive in a market segment, the price set by an automaker must coincide both with consumers' willingness to pay and be within the range of prices of comparable vehicle offerings. Better quality, reliability, comfort and safety attributes, and other characteristics that differentiate a vehicle from another vehicle in its segment allows for a higher price. The economics

literature is filled with studies that examine the price-quality relationship.[52] The brand in addition to the price may assist the consumer in determining the overall quality of the vehicle. Pricing that is too low may have the undesired consequence of convincing consumers the product is of inferior quality. Of course, pricing that is too high may also turn off consumers who believe that the price is not a fair one. In recent years, the Internet in particular, has given consumers an advantage in new vehicle transactions by making the dealer cost readily available. This cost transparency, in addition to the proliferation of rebate offers and other financial incentives, has made the MSRP an increasingly inexact measure of the actual transaction price.

A detailed 1978 report prepared for the US Department of Transportation found there to be four overarching factors that influence automakers' pricing policies.[49]

1. ***Volume Orientation*** – According to the report, theoretical studies of elasticity indicate that demand for new automobiles is not exceptionally sensitive to price increases. But automakers position their product lines against those of their competitors in such a way as to maximize their market share. The importance in pricing then becomes how a certain vehicle is priced with respect to comparable, competing vehicles. Automakers are usually willing to shrink profit margins to some degree in order to sell more vehicles – especially when they have excess manufacturing capacity and also because the initial selling of a vehicle is just the first transaction in a revenue stream that may last the lifetime of the vehicle.
2. ***The Product Planning Process*** – There is no evidence that automakers employ a uniform cost-based approach across their fleet of vehicles when setting prices. Instead, profit margins in terms of both return on sales and return on investment vary a great deal from vehicle to vehicle, and these inconsistencies are recognized by automakers as essential in the effort to maintain a wide range of product lines that appeal to a spectrum of market segments. For example, automakers can make as much as $15,000-$20,000 on high-end luxury cars and SUVs, but at the same time, essentially break even on fuel-efficient, 'budget boxes.' As a result, price targets are principally determined from both past experience and expectations of future purchase behavior. A price target (sometimes but not always the MSRP) is the amount an automaker hopes a consumer will pay for a vehicle. The fundamental question the automakers ask is: Given current market conditions, how much are consumers willing to pay for a vehicle that has these attributes and features?
3. ***Parochialism*** – This describes the tension that exists within an automaker between finance groups that favor pricing policies that lead to higher profit margins, and sales groups that favor slightly deflated pricing in order to achieve greater sales volume.
4. ***Fine Adjustment Mechanisms*** – While automakers set an MSRP when a vehicle is introduced, this list price may change numerous times over the course of the year if consumer response does not meet original expectations. The manufacturer may adjust the price and/or demand by offering rebates directly to the public, increasing advertising, enacting a sales incentive program, presenting a special promotion such as option packages at a discount, providing the dealer with a rebate, or offering fleet discount programs to volume buyers. Dealers who are left

with excess inventory may be forced to take similar measures that eat into their profit margins.

3.4.3 Cost Transfer for the Introduction of Airbag Systems

The pivotal 1990 model year, driven by the passive restraint regulation, witnessed the first widespread introduction of driver airbag systems in the U.S. vehicle market. The number of such cars expanded from well under one million to well over two million vehicles. It was reported that Ford Motor Co. and Chrysler Corp., the two companies spearheading the airbag race, would pass on to consumers the cost of the federally mandated airbags, contributing to price hikes as high as $1,300 on some models.[53] For instance, it was reported that Chrysler would boost prices on its 1990 model cars by an average of five percent. The company blamed much of the rise on the cost of federally mandated passenger restraints, particularly airbags.[26] Chrysler added more than ½-million airbag-equipped cars over the previous year, which cost the company upwards of a quarter of a billion dollars if each unit installed is assumed to cost $500. Similarly, Ford and Chrysler had tentatively increased prices 3 percent to 9 percent over 1989 on early 1990 car and truck models being sold to fleet owners, in part because of the new government requirement for air bags or passive seat belts.[54] Spokespersons for Ford, Chrysler and General Motors also confirmed that the automakers would pass along to buyers the cost of the mandated safety equipment on 1990 model year cars. The Big Three stated that by choosing to install the pricier passive restraint option for many models, the companies had to raise prices for 1990 cars much more than their Japanese competitors, which equipped nearly all their models with the considerably less costly automatic seatbelt (See Appendix B for detailed installation rates).[55] The Big Three raised their prices by an average of $805, compared with $205 for Japanese cars. While 1990 was a very pivotal year for Ford and Chrysler, GM committed to airbags later, so the impact was felt more acutely for GM in the 1991 and 1992 model years. GM announced big price increases on some of its 1992 models that the company said largely reflected the addition of airbags as standard equipment.[56]

Tables 3-7 and 3-8 show the effect that making airbags standard equipment has on vehicle prices on an aggregate basis. The Driver-side airbag column indicates that a driver airbag was made standard, while the passenger-side airbag and dual airbags columns indicate that a passenger airbag and dual airbags respectively were made standard. Also included are the impact of ABS and the average cost increase for years when neither airbags nor ABS were made standard. The tables also break down the average cost and percentage increase by a number of price brackets and vehicle classes to provide a clearer picture of the nature of the cost pass-through. The vehicles analyzed were the base versions of particular models during the timeframe of 1988 to 2000. *Ward's Automotive Yearbook* was used as the source for vehicle price data and available standard equipment. Other changes between model years were not taken into account in the analysis. Automobile manufacturers traditionally make annual changes to vehicles to enhance their marketability and to meet Federal and State requirements. These changes include interior and exterior trim, minor exterior body parts, major structural design and styling, drivetrain, and the platform. These changes may or may not be directly reflected in the price of the vehicle. Trim changes usually occur every year and include the interior trim, exterior bumpers, paint, and front and rear styling. Minor changes to exterior body

parts occur every two to three years and include fenders, hood, and trunk lid, but do not include structural parts. A major change to structural design and styling may occur about every four years and includes distinctive changes to the exterior body parts, which may change the dimensions of the vehicle, but not the drivetrain. Changes to the drivetrain often occur every two to three years and include engine displacement, type of engine, transmission, and drive wheels. The change to the body family or platform occurs when an entirely new vehicle is designed.[57] The vehicle prices were converted into constant 2002 dollars using the new vehicle consumer price index furnished by the Bureau of Labor Statistics.

Table 3-7 Change in Average Vehicle Price when Airbags & ABS are made Standard (Price)

Car Price (2002$)	$/% change	No Change (n = 556)	Driver-Side Airbag (n = 78)	Passenger-Side Airbag (n =72)	Dual Airbags (n = 15)	ABS standard (n = 137)
< 15k	$ %	$386 3.00%	$393 3.18%	-$311 0.11%	$657 5.96%	$770 6.74%
15k – 25k	$ %	$581 3.12%	$1,055 5.92%	$799 4.29%	$119 0.66%	$1,148 5.99%
> 25k	$ %	$830 2.54%	$1,129 3.59%	$1,341 3.43%	$1,701 5.40%	$1,135 3.15%
Average All Vehicles	**$ %**	**$606 2.76%**	**$861 4.14%**	**$898 3.34%**	**$581 3.51%**	**$1,045 5.28%**

Table Notes: 1.) The (n) refers to the number of consecutive year vehicle model pairs. In the case of 'no change,' there are 120 distinct models spread over multiple years, so there are a total of 556 Δ price entries. In the case of the other variables, (n) equals the number of vehicle models tested. **2.)** The cost change is calculated as an aggregate average. **3.)** No Change simply means airbags or ABS were not made standard, although other major changes (styling, new attributes, etc…) may have been made. **4.)** The sample covers model years 1988-1998.

Table 3-8 Change in Average Vehicle Price when Airbags & ABS are made Standard (Veh. Class)

Vehicle Class	$/% change	No Change (n = 556)	Driver-Side Airbag (n = 78)	Passenger-Side Airbags (n =72)	ABS standard (n = 137)
Small Car	$ %	$268 1.97%	$370 2.67%	-$296 -0.33%	$1,502 10.29%
Midsize Car	$ %	$449 2.51%	$1,175 7.68%	$1,185 7.15%	$464 2.60%
Large Car	$ %	$572 2.77%	$1,487 7.62%	$1,035 4.88%	$1,445 6.94%
Luxury Car	$ %	$710 2.00%	$955 2.80%	$1,170 2.68%	$1,159 3.61%
Sports Car	$ %	$820 3.99%	$551 3.42%	$1,023 5.78%	$927 4.87%
Minivan	$ %	$1,448 6.52%	$1,866 10.66%	$1,658 6.88%	$912 5.22%
SUV	$ %	$1,463 5.04%	$1,208 4.35%	$1,827 5.82%	$1,351 6.40%
Average All Vehicles	**$ %**	**$606 2.69%**	**$861 4.14%**	**$898 3.34%**	**$1,045 5.28%**

Table Notes: Same as Table 3-7; Consult Appendix C for complete descriptive statistics associated with this analysis.

The introduction of ABS as standard equipment was associated with the greatest degree of change in price homogeneity in dollar terms. Vehicles that do not undergo a safety attribute installment display the most consistent change in percentage change in price. The cost of ABS, which has been reported to be in the neighborhood of $500 to $1000 dollars or more depending on the make of vehicle, is passed on fairly consistently to consumers of all price-level cars. A more stable cost pass-through may accompany the

addition of ABS because automakers had much more freedom to choose which vehicles would receive the safety upgrade. Such a straightforward pass-through is not the case for airbags perhaps partly due to the requirement to add the safety feature to all vehicles over a relatively short period of time.. When a driver airbag is added, the cost burden is disproportionately placed upon the most common price-level of cars (i.e. $15,000-$25,000). Strangely, cars costing over $25,000 have a smaller dollar figure increase than when no safety feature is added. The small sample sizes (n) mean that the results are not statistically significant, and may be skewed in one direction or the other.

Figure 3-3 Average MSRP Increase with Airbags, ABS, and Neither Added

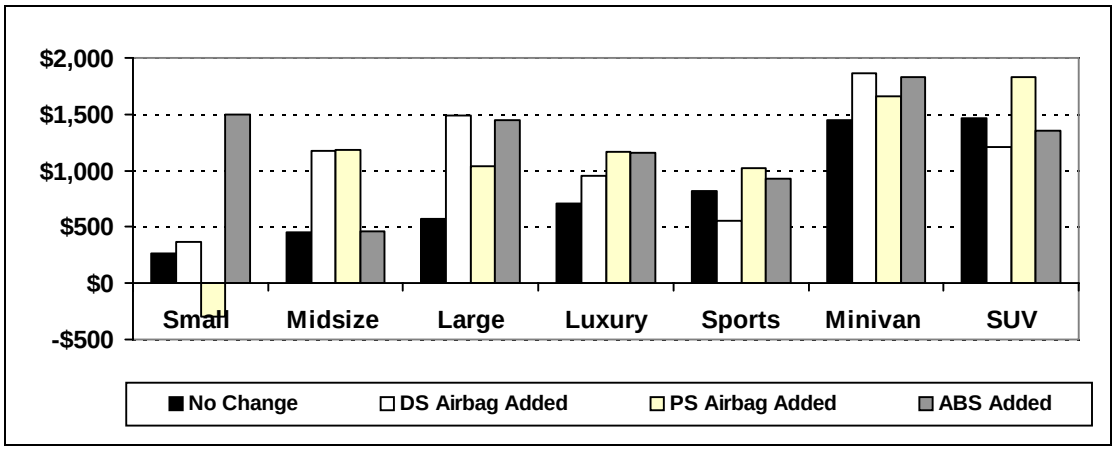
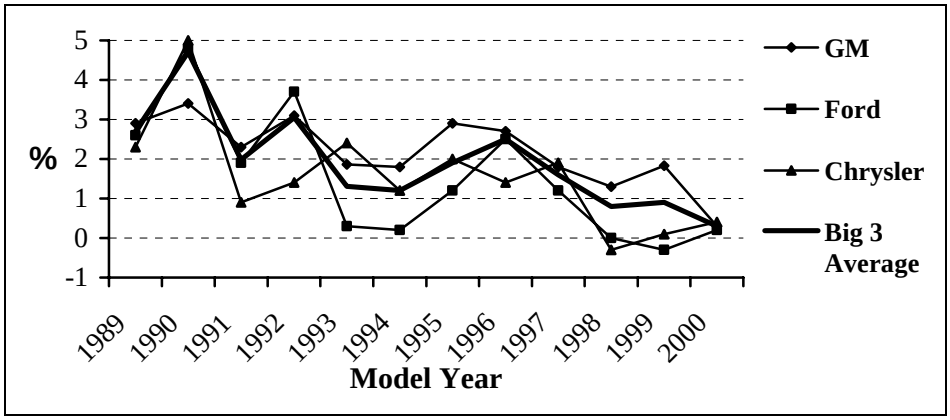


Table Notes: The data used in this figure is for vehicles (all major manufacturers) from 1988 to 1998. These results are the same as those presented in Table 3-8. DS = Driver-Side; PS = Passenger-Side

As Figure 3-3 shows, the trend in price shifts indicate that larger vehicles receive a higher price increase on average than small cars. When a car moves from having a single airbag to dual airbags, the cost pass-through is weighted toward the more expensive cars (as indicated by the fact that the price increase is no greater for 2 airbags than one, even though the cost much be greater). In this case the price of cars that cost under $15,000 actually see lowered prices in constant dollars. Automakers decided to forgo an incremental installation on some models, and move straight to dual airbags. This action is in many cases regulatory-driven because automakers thereby satisfy the dual airbag requirement that went into effect during the 1995 – 1998 model years. In this instance, the most prevalent price-level of cars once again yields unexpected results. The cost of the dual airbag systems is clearly not passed on initially to the consumer of cars costing between $15,000 and $25,000. The data indicate that the unregulated technology, ABS, has a higher price premium than airbags. This may be due to automakers' opinion that there is less demand for a regulated safety feature, so the added cost must be kept low in order to not negatively impact sales. More than anything these tables along with Figure 3-4 show the unpredictability and complexity of automaker's pricing policies. Consult Appendix A for detailed price and sales analyses in response to the introduction of airbags for individual vehicle models. The results in the appendix more clearly show how automakers pass on added costs across a number of their highly differentiated vehicle offerings. For the most part, higher-end cars receive disproportionately higher price increases than their more budget-targeted counterparts. There is also a great deal of fluctuation in price setting from one year to the next, which highlights the range of

factors, only some of which are cost-related, which help to determine the price of a new vehicle.

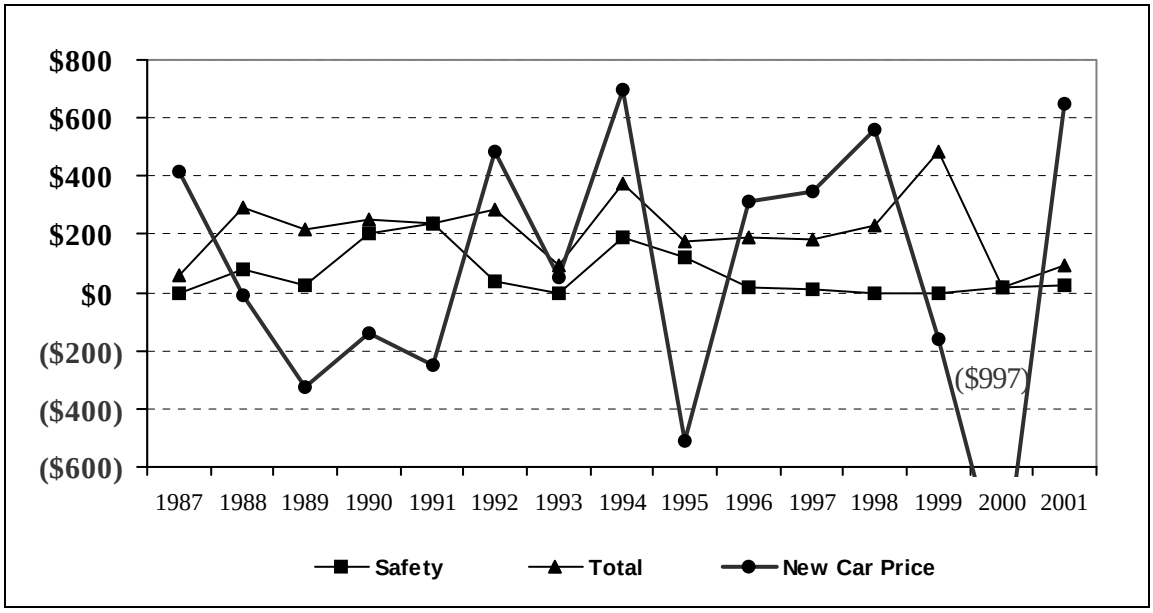
Figure 3-4 Average Fleet-Wide Percentage Annual Increase in New Car Prices



Source: Numerous issues of *Automotive News* (1988-2000). The percentage change is strictly price increases (i.e. Cost of quality improvements like those generated by BLS to a car are not factored into the change).

The Bureau of Labor Statistics publishes the price differential for quality changes to new vehicles. These quality changes include such items as powertrain improvements, corrosion protection, theft protection, changes in levels of standard and optional equipment, as well as mandated safety and emissions control improvements. For example, BLS tracks the price change resulting from the Federal Motor Vehicle Safety Standards, such as FMVSS 208, that governs airbags, and the price change in accordance with the Clean Air Amendments of 1990. BLS decided that, beginning in 1999, it would no longer treat modifications to goods and services that are made solely to meet air quality standards as quality improvements in the CPI. Price increases associated with such modifications were to be treated as increases in the index. The rationale behind this decision is that a change in pollution control in no way changes the satisfaction derived from the vehicle by the individual consumer. This fundamental difference between emissions regulations that primarily lead to *public benefits* and safety regulations where the derived *private benefits* are transparent will be discussed at length in Section 4.4. Consult Appendix D for a synopsis of quality adjustments for passenger cars from 1969 to present.

Figure 3-5 Average Retail Price Changes for Quality Improvements[1] and Average Change in Car Price[2] ($2001)



Source: Bureau of Labor Statistics, Reports on Quality Changes for New Cars as reported in *Ward's Automotive Yearbook 2002*. U.S. Department of Commerce, Bureau of Economic Analysis, *National Income and Product Accounts*, underlying detail estimates for Motor Vehicle Output, Washington, DC, 2002. (Additional resources: www.stat-usa.gov) These data apply to passenger cars only (not light trucks). See **Appendix D** for Source Data.

BLS estimates the value of quality change based on a review of data supplied by producers for similarly equipped previous model year and current model year domestic models priced for the Producer Price Index. Essentially, price changes above and beyond the change due to quality improvements can be construed as a change that is not covering an explicit cost. An implicit cost such as this would perhaps cover manufacturing or some other cost that would not be considered to add quality to the new vehicle. BLS lists both producer prices as well as the retail price equivalent of quality improvements. Figure 3-5 highlights the retail price adjustments over the period between 1987 and 2001. The most important years for passive restraint regulation and airbags are 1988 ($78.12), 1990 ($205.26), 1991 ($239.60), 1994 ($188.94), and 1995 ($120.36). The cost figures in parentheses are the retail safety adjustments, which are almost entirely attributable to passive restraints for those years. For the 1988 model year, the regulation called for 25% of automakers' passenger cars to be equipped with passive restraints up from 10% the previous year. In 1990 this number jumped from 40% to 100%, which was reflected in the price increase. Up to this point, a mix of mostly automatic safety belts and some driver airbags caused the cost of these mandated safety improvements. This changed in the following years when airbag installation approached 100% of vehicles. Table 3-9 highlights the compliance cost per vehicle for passive restraints according to BLS data. Note that cost appears to be spread out over the course of a number of years and, if these numbers are to be believed, may not be recouped at all judging by the average change in new car price. Of course, the average change in new car price is not a good measure for determining cost pass-through dynamics because it fails to get at what is happening on a manufacturer by manufacturer (and vehicle class by vehicle class) basis.

Table 3-9 Summary of Statistics related to the Introduction of Airbags (1987-1997)

Model Year	Average per unit safety cost[1] ($2001)	Average Change in New Car Price[2] ($2001)	Number Cars Sold w/ Auto Seatbelts[3]	Number Cars Sold w/ Driver Airbags[3]	Number Cars Sold w/ Passenger Airbags[3]	Passenger Car Sales[3]
1987	$0.00	$355.59	1,570,000	106,789	0	10,277,000
1988	$78.12	-$304.24	3,100,000	210,137	0	10,530,000
1989	$27.11	-$537.19	3,900,000	630,295	0	9,772,000
1990	**$205.26**	**-$388.66**	6,050,000	2,331,614	20,657	9,300,000
1991	**$239.60**	**-$492.60**	5,100,000	3,015,945	72,456	8,175,000
1992	$37.68	$202.55	3,800,000	3,995,231	431,988	8,214,000
1993	$0.00	-$39.59	2,500,000	5,030,813	1,257,478	8,518,000
1994	**$188.94**	**$323.74**	950,000	7,238,642	5,008,146	8,990,000
1995	**$120.36**	**-$684.01**	0	8,152,637	7,220,844	8,735,197
1996	$16.31	$125.56	0	8,366,340	7,911,639	8,653,927
1997	$8.97	$164.22	0	8,200,000	8,200,000	8,257,404

Sources: 1) Bureau of Labor Statistics, Reports on Quality Changes for New Cars as reported in *Ward's Automotive Yearbook 2002*. **2)** U.S. Department of Commerce, Bureau of Economic Analysis, *National Income and Product Accounts*, underlying detail estimates for Motor Vehicle Output, Washington, DC, 2002. **3)** Ward's Automotive Yearbook, (Various Years).

3.4.4 Impact of Airbag Regulation on the Auto Industry

Motor vehicle manufacturing accounted for 3.7% of the overall U.S. GDP in 2000.[58] The US automobile market is the largest in the world, and the automotive industry ranks among the top in the nation in terms of R&D spending and employee payroll.[59] Although average profit margins tend to be relatively small, great variability can be found across vehicles. American automakers in particular display a range of profit margins from close to zero for some vehicles to upward of $20,000 for others, such as luxury SUVs. Many small and midsize cars from Detroit such as the Dodge Neon, Chevrolet Malibu and Ford Focus have very little if any profit margin, but play an important role in helping automakers meet CAFE standards and attracting first-time buyers. American automakers have increasingly moved away from passenger cars in favor of light trucks, particularly SUVs. In 2002, the percentage of total vehicle sales accounted for by light trucks was 58% for GM, 65% for Ford, and 76% for Chrysler.[60] Most premium American SUVs generate profits between $5,000 and $15,000 per vehicle, while highly profitable lines such as the Lincoln Navigator and the Cadillac Escalade can generate up to $20,000. The optional accessories package on a Hummer H2 has an average profit margin of $1,300, which helps overall profitability.[61] Overall, though, the profit margins for the auto industry are slim compared with other industries (See Table 3-10). Table 3-11 summarizes select automaker financial statistics and number of airbags during the period of 1988 to 1997 when automakers introduced airbags across their entire vehicle lines to satisfy the regulation. The ratio of corporate revenue to profits illustrates the thin profit margins in the auto industry, but also the enormous revenues the industry generates.

Table 3-10 Average Profit Margins for a Number of Industries

Industry	Net Profit Margins
Automobile & Truck Manufacturing	**1.43%**
Mobile Homes & RVs	5.66%
Aerospace & Defense	5.79%
Computer Networks	6.44%
Insurance (Life)	9.17%
Computer Hardware	9.38%
Healthcare Facilities	9.88%
Waste Management Services	10.90%
Office Supplies	12.63%
Motion Pictures	15.71%
Biotechnology & Drugs	19.28%
Software & Programming	27.68%

Source: Reuters Investor Website, See:
http://cnnfn.investor.reuters.com/Home.aspx?target=%2f&page=home

Table 3-11 Summary of Financial and Airbag Statistics for Select Automakers (1988-1997)

Auto-maker	Statistics	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1988-1997
Chrysler	Driv. AirBag	58,730	144,912	653,536	603,125	537,761	521,403	341,823	48,316	46,355	32,565	**2,988,526**
	Dual Airbag	0	0	0	0	0	168,645	458,297	770,669	757,841	770,222	**2,925,674**
	Net Revenue	$34,421	$31,039	$26,965	$26,707	$33,409	$41,247	$49,534	$49,747	$58,004	$56,967	**408,040**
	Net Profit	$1,050	$359	$68	($795)	$723	($2,551)	$3,713	$2,025	$3,529	$2,805	**10,926**
Ford	Driv. AirBag	13,471	223,455	770,305	879,240	707,195	552,411	346,357	0	0	0	**3,492,434**
	Dual Airbag	0	0	0	0	284,124	625,119	1,232,702	1,941,570	1,491,167	1,674,107	**7,248,789**
	Net Revenue	$92,446	$82,879	$81,844	$72,050	$84,407	$91,568	$107,137	$110,496	$118,023	$122,935	**963,785**
	Net Profit	$5,300	$3,175	$99	($3,186)	($8,628)	$940	$3,824	$2,056	$1,655	$4,714	**9,949**
GM	Driv. AirBag	2,896	276,190	416,648	917,965	1,031,246	1,385,698	1,263,420	823,653	408,346	113,444	**6,639,506**
	Dual Airbag	0	0	0	0	19,488	161,570	1,191,766	2,331,314	2,298,506	2,532,303	**8,534,947**
	Net Revenue	$123,642	$112,533	$110,797	$109,157	$118,572	$125,253	$141,576	$143,754	$145,427	$153,781	**1,284,492**
	Net Profit	$4,856	$4,224	($1,986)	($4,661)	($23,498)	$2,466	$4,901	$6,881	$4,963	$6,698	**4,844**
BIG 3 Total	Driv. AirBag	75,097	644,557	1,840,489	2,400,330	2,276,202	2,459,512	1,951,600	871,969	454,701	146,009	**13,120,466**
	Dual Airbag	0	0	0	0	303,612	955,334	2,882,765	5,043,553	4,547,514	4,976,632	**18,709,410**
	Net Revenue	$250,509	$226,451	$219,606	$207,914	$236,388	$258,068	$298,247	$303,997	$321,454	$333,683	**2,656,317**
	Net Profit	$11,206	$7,758	($1,819)	($8,642)	($31,403)	$855	$14,418	$9,044	$11,882	$12,363	**25,662**
Toyota	Driv. AirBag	0	0	61,422	144,726	407,498	229,403	12,240	5,700	0	0	**860,989**
	Dual Airbag	0	0	0	0	0	62,038	644,420	768,197	782,296	836,651	**3,093,602**
	Net Revenue	NA	$61,440	$59,962	$71,731	$80,128	$95,063	$91,317	$89,715	$101,177	$99,730	**750,263**
	Net Profit	NA	$2,652	$2,878	$3,140	$1,875	$1,643	$1,227	$1,458	$2,426	$3,143	**20,442**
VW	Driv. AirBag	0	1,490	31,864	13,174	18,195	8,501	0	0	0	0	**73,224**
	Dual Airbag	0	0	0	0	0	7,784	61,669	128,440	156,681	173,037	**527,611**
	Net Revenue	NA	$37,606	$45,429	$48,826	$53,977	$44,774	$50,930	$61,168	$64,491	$63,664	**470,865**
	Net Profit	NA	$597	$725	$713	$93	($1,134)	$95	$233	$437	$765	**2,524**

Source: Ward's Automotive Yearbook 2002, Compiled from annual company reports. **Table Notes:** Revenue and Profit are reported in $2001 and represent global figures. Airbag statistics are for the U.S. vehicle market only.

3.5 MARKETING COMPLIANCE-RELATED VEHICLE ATTRIBUTE CHANGES

3.5.1 Advertising the Airbag

After years of fighting proposed regulation that would require airbag systems, many in the auto industry did an about face and embraced airbag technology as a desirable safety feature. The most dramatic illustration of this reversal is Lee Iacocca who, as president of Ford in the 1970s, fought vigorously against the adoption of an airbag rule on the grounds of cost and the difficulty of competing with import automakers. Then, as CEO of Chrysler Corporation in the late 1980s, he committed to airbags before regulation required such a committal, and before the consumer demand and acceptance of airbags was clear. In 1988, it was reported that manufacturers and dealers, who understandably found risk of injury and death an unattractive item to market, had yet to actively promote the safety technology.[62] Until fairly recently it was not automakers who advertised the airbag most directly, but rather auto insurers and suppliers. The importance of advertising in the overall corporate marketing strategy cannot be dismissed. Automakers support dealers through extensive advertising and promotional campaigns. As a whole, automakers led all other industries in spending on broadcast, print, and billboard advertising in the U.S, with total expenditures of $7.43 billion in 1998, up from $6.79 and $5.74 billion in 1997 and 1996.[63] GM alone spent $2.94 billion on advertising, or about $643 per passenger vehicle it sold that year. In addition to these advertising expenditures, carmakers also spent an average of $2,000 per vehicle in rebates and other incentives to both consumers and dealers in 1998, costing the industry more than $30 billion.[64] The trend toward more generous rebates has continued to the present time.

3.5.2 Early Efforts by Mercedes-Benz

Mercedes-Benz was the first prominent automaker to include airbags in its marketing pitch as part of an overall safety and superior engineering and design campaign. The company slogan used in their advertising at the time was in fact, “Engineered like no other car in the world,” and the inclusion of airbag technology, which during the timeframe of 1984-85 was unavailable from any other manufacturer, was a case in point of the slogan. The automaker’s advertising focused heavily on safety including the company’s anti-lock braking systems (ABS), and the patented supplemental restraint system (SRS), which included an airbag system. The ads involved test track and laboratory settings that further emphasized the company’s professed scientific and engineering prowess.

A 1984 television advertisement depicted a series of dummy crash tests that involved an airbag deployment in slow motion. The commercial acts as an educational device for the consumer who may be unfamiliar with the technology, or may have been exposed to disparaging or conflicting reports about airbags in the press and elsewhere. The viewer also takes away the idea that Mercedes is committed to the safety of their vehicles, which had been an expressed corporate objective since the patenting of the passenger safety cell (a safety improvement to a car’s inner compartment) and its requisite marketing in 1951. A later TV commercial from the 1980s shows a lead

engineer for Mercedes being interviewed about this revolutionary patent. The tag line is delivered when the engineer explains in his thick German accent that Mercedes has never enforced the patent despite its use by many other automakers because "some things are more important than money." The message directed at the consumer seems to say, "buying a Mercedes-Benz is an extension of you as a thoughtful, caring person." A 1965 television commercial gives a rundown of all the safety features present on a Mercedes, including its shock-absorbing, padded and flexible interior. Once the technology is clearly demonstrated as in the above crash test spots, the 1984 and 1985 commercials frequently mention the availability of an airbag as a standard or optional feature.

3.5.3 The importance of an Effective Marketing Campaign for GM

The role of marketing in introducing future technologies such as ones to reduce GHG emissions is critical to consumer acceptance of those technologies. Looking back at how GM has marketed airbag technology and new vehicles in the past may provide some rules to follow.

Prior to the successful Daimler-Benz airbag marketing campaign was the admittedly failed marketing (or lack thereof) effort behind GM's dual airbag system that the automaker offered on a number of its full-size Cadillacs, Oldsmobiles, and Buicks during the 1974-76 model years. GM had at first promised to produce over a million airbag-equipped cars, but this number was later cut to 150,000. Unfortunately for airbag proponents and GM, the airbag turned out to be a tough sell and the final tally of airbag-equipped cars sold during this time was a little over 10,000. The question arose whether airbags were a tough sell because consumers were not willing to pay for the safety device, or whether GM and its dealers in effect relegated airbags to this lowly standing by not marketing them properly, and even discouraging customers from purchasing the safety devices in certain instances.

Normally dealers are happy to comply with the customer's choice of options, but this simply was not the case for airbags according to a 1976 *Wall Street Journal* article.[19] A survey of car buyers and GM dealers conducted by the newspaper found that many dealers, like the public in general, knew little about the airbag, mentioned the safety option rarely to customers, and often dissuaded interested car buyers from purchasing a car equipped with airbags. The article depicts GM's relationship with the airbag to be an "on-and-off affair, an odd episode in the annals of auto marketing." According to the report, a number of car buyers who were interested in the airbag-equipped car had a difficult and sometimes impossible time locating one from the dealer. Clarence Ditlow, the Executive Director of the Center for Auto Safety, raised the same issue during sworn testimony before a Congressional Subcommittee. Ditlow stated that dealers have to do three things to sell optional equipment: 1) Have cars in stock at the dealership to show customers 2) Place advertisements in the TV media and 3) Have a brochure explaining the optional equipment for a consumer to look at in the showroom.[65] During the same hearing, GM responded in writing to the following question posed by the Chairman of the Subcommittee.

> *What did General Motors do to promote the air bag cars it sold between 1974 and 1976? Did you promote the airbag through advertising on television, in magazines, through incentives to the dealers, through packaging with other options? What percentage of your dealers had a*

significant supply of cars with air bags in stock on their lots? How does the marketing of the air bag during this period compare with the air conditioner and the automatic transmission when these items were first offered as options in your cars?

General Motors' response:

General Motors provided a 10-minute film presentation showing the operation and potential restraint provided by the air bag system to all Cadillac, Buick and Oldsmobile dealers. This film could be shown by the dealers in the "mini theaters" which General Motors used at the time to provide information to customers on a wide variety of products.

In addition, General Motors placed a newspaper advertisement in the top 20 markets in the United States as well as in national news publications. This full-page advertisement centered on the availability of the air bag option and invited prospective buyers to visit General Motors' dealerships to obtain additional information. It should be noted that, in addition to these efforts, the air bag was offered at a price substantially below its actual cost to General Motors.

Data are not available as to the supply of cars with air bags in dealer stocks during the 1974-76 period, nor are specific data available which compare the marketing effort for air bags with that of air conditioners and automatic transmissions when first offered.[65] (pp.342-3)

Clearly, there was a large discrepancy between GM's characterization of their marketing effort and how it was perceived by airbag proponents. A GM study at the time concluded the many car buyers at the time thought airbags to be a desired attribute.[66]

GM has also had its share of successful marketing campaigns. GM introduced its mid-sized Cadillac Catera in the 1997 model year. The Cadillac market had traditionally consisted of older, loyal customers, but such a market showed little chance for growth. The Catera was designed to grow and diversify the Cadillac market by competing in one of the fastest growing vehicle segments, the entry-level luxury car. Cadillac dealers had to develop new strategies to sell a car to untraditional Cadillac car buyers. Along with a number of standard dealer incentives, GM included an educational component to the marketing campaign, coined Catera College. The college consisted of two ½-day sessions to teach dealers and managers about the new customer base and the issues surrounding the vehicle.[67] Dealers drove the car and saw it taken apart piece by piece in an effort to learn the selling points of the car. The dealers were also taught the demographics and characteristics of the market segment relevant to the Catera. The dealers were reported to be enthusiastic about the training program because it was an opportunity to increase their sales. GM has used similar marketing practices to introduce new vehicles and options, but the cooperation and enthusiasm of the dealers is necessary for a successful program. This was the key ingredient missing with the initial airbag campaign.

3.5.4 Ford and Chrysler Follow Mercedes' Lead in Different Ways

Ford Motor Co. followed shortly after Mercedes-Benz to become the only domestic automaker to offer an optional airbag for the 1986 model year. The company had already sold over 5,000 airbag-equipped Tempos to the Federal government, which helped to jumpstart their commercial airbag program. Ford received some of the same criticism GM had had to endure in the 1970s. It was reported in *The Wall Street Journal* that car buyers faced stiff opposition from Ford and its dealers when requesting the airbag option.[68] The cause for this resistance may have been concerns over liability and perhaps a deliberate limited supply of airbags. Ford contended at the time that the company was losing money on the $815 option.

In 1988, Chrysler boldly announced that it would equip all of its new cars with driver-side airbags by 1990.[69] The marketing campaign that followed was unprecedented in its dramatic push for airbags. The advertising was handled by the Bozell firm, which developed a cascade of television commercials in 1990. A series of these television commercials involved Lee Iacocca sitting across from a person who had survived a horrific automobile accident presumably because of the timely airbag deployment in their Chrysler vehicle. The commercials have a personal quality rarely seen in automobile advertising with the name and place of residence of the accident survivors given visually at the start of the spot. The first of these featured Karen McGowan from Columbia, Maryland, who was able to refuse emergency medical care after her Chrysler LeBaron crashed head-on into a tree. She exclaims, "luck had nothing to do with it, that airbag saved my life." Iacocca ends the commercial by saying, "I could give you a dozen reasons why you should consider a Chrysler product, but today I will give you just one: Karen McGowan." McGowan's personal account of the accident is stirring because it is a near-death experience related from someone who strongly believes an airbag is the sole reason she is still alive. Similar commercials include a reverend and a pair of married couples, all of whom are presented as ordinary people who could be your neighbor. These testimonials helped to depict the airbag as a life-saving device that nobody should be without.

Another memorable commercial has a stuntman pick up and throw a crash test dummy out of a Chrysler car. The stuntman next occupies the car, fastens his seatbelt and proceeds to drive into a fixed barrier at 21 mph, which activates the airbag. A close-up of the stuntman safely striking the airbag is shown in slow motion followed by his nonchalant exiting of the vehicle. Such a test is meant to further build consumer confidence in the new airbag technology. Where in the past, Mercedes showed a dummy colliding with an airbag; Chrysler upped the ante by showing an actual person. Yet another television spot reconstructs an historic post-collision scene on a rural road in Virginia. This is the first reported collision between airbag-equipped vehicles where two Chrysler LeBarons collided head-on and both drivers survived with only minor injuries. Chrysler seized this serendipitous accident to create a powerful commercial. The poignancy of these commercials is punctuated by the fact that Chrysler was the only domestic or Japanese automaker to include airbags on the majority of its passenger car line, as Iacocca is quick to point out in the commercials. Iacocca shrewdly recognized that the airbag could be an easy way to differentiate his company's product from the competition.

A shift was also taking place in the marketplace toward greater consumer valuation of safety features. Bob Munson, director of Ford's auto safety office, summed this up in 1989 – "Our market studies show in the past three years, safety more and more has become an issue that affects what product people buy."[70] The old auto-marketing adage that "safety doesn't sell" was no longer applicable. No other automaker used the airbag as a focal point in the way Chrysler had, but more and more advertisements over the course of the early 1990s mentioned the airbag, thus positioning the safety device as a marketing tool. European automakers such as Volvo, Mercedes, and Saab continued their long-standing tradition of actively promoting safety features, but now they were joined by a host of American and Japanese automakers as well. Toyota marketed their Previa by offering the "43 Best Reasons" for driving the minivan – its conformity to 43 federal car safety standards. Ford capitalized on the availability of dual airbags by featuring the safety devices prominently in its ads for the company's flagship passenger car, the Taurus. General Motors, which lagged behind Ford and Chrysler, focused its safety marketing on ABS, which helped distinguish GM from its competitors. Virtually every automaker helped promote the introduction of airbags into their vehicle lines through advertising.

3.5.5 Negative Portrayals of Airbags in Automakers' Marketing

Throughout the 1970s and into 80s many factions in the auto industry claimed that airbags were dangerous, would be impossible to test in time to implement, were not the most cost effective way to reach the objective of lower motor vehicle fatality and injury rates, and were susceptible to inadvertent deployment. A Ford advertisement raised the prospect of "driving along at 60 mph and suddenly having an enormous pillow thrust in your face." NHTSA and safety groups insisted that such an incident had never occurred in millions of miles of testing. GM and Volvo among other automakers warned of the dangers of out-of-place occupants and children. These latter warnings proved to be true when a number of deaths were caused by airbags inflating in low severity crashes. From 1990 until 2003 231 such deaths reportedly occurred. These deaths included 79 drivers, 10 adult passengers, 119 children, and 23 infants. In the midst of the bad press generated from these reports, the automakers and other corporations formed a coalition called the Air Bag Safety Campaign, which among other educational initiatives produced advertisements promoting airbag safety, including the one shown in Figure 3-6. In addition, automakers responded vigorously. For instance, Volvo Cars of North America ran TV ads encouraging parents to put their children in the backseat, GM sent letters to 7 million of its vehicle owners and ran a host of radio spots, and Chrysler Corp. started its own airbag safety mail campaign.[71]

Figure 3-6 Big 3 Automaker Advertisement on Airbag Safety (1997)

Air Bag Safety

An *important* message from America's Car Companies

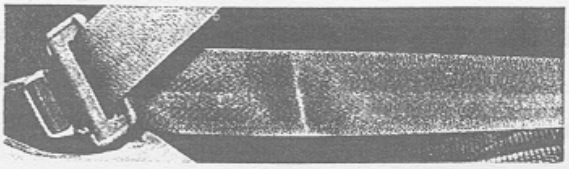
Air bags and safety belts save lives, but for children air bags can be deadly.

Everyone who transports children should know this lifesaving information as recommended by the National Highway Traffic Safety Administration and the National Transportation Safety Board:

- It's safer for children 12 and under to ride buckled up in a rear seat.
  - Infants in rear-facing child safety seats should NEVER ride in the front seat of a vehicle with a passenger side air bag.
  - Small children should be secured in a rear seat in child safety seats approved for their age and size.
  - Older children should ride properly buckled up, and they also are safer if they ride in a rear seat.
  - NEVER allow children to slide the shoulder belt behind them.
- Every occupant should be properly belted, whenever possible with both lap AND shoulder belts. (Remember, 49 states and the District of Columbia have safety-belt-use laws, and all 50 states have child-safety-seat requirements.)
- Driver and front passenger seats should be moved back as far as practical.
- Check your vehicle owner's manual and the instructions provided with your child safety seat for correct use information.

American automobile manufacturers have petitioned the Federal government to immediately allow air bags in new cars to deploy with less force. Automakers and their suppliers also are actively developing new, longer-range technologies such as "smart" air bags that will help provide even more protection.

But the fact is – with or without an air bag – children always are safer in a rear seat. That's why America's Car Companies joined with international automakers, insurers, air bag manufacturers, safety advocates and the Federal government to send a simple message:



Every time you drive, remember...
Buckle up, Children in back.

CHRYSLER CORPORATION

Ford

GM General Motors

A message from Chrysler Corporation, Ford Motor Company and General Motors Corporation

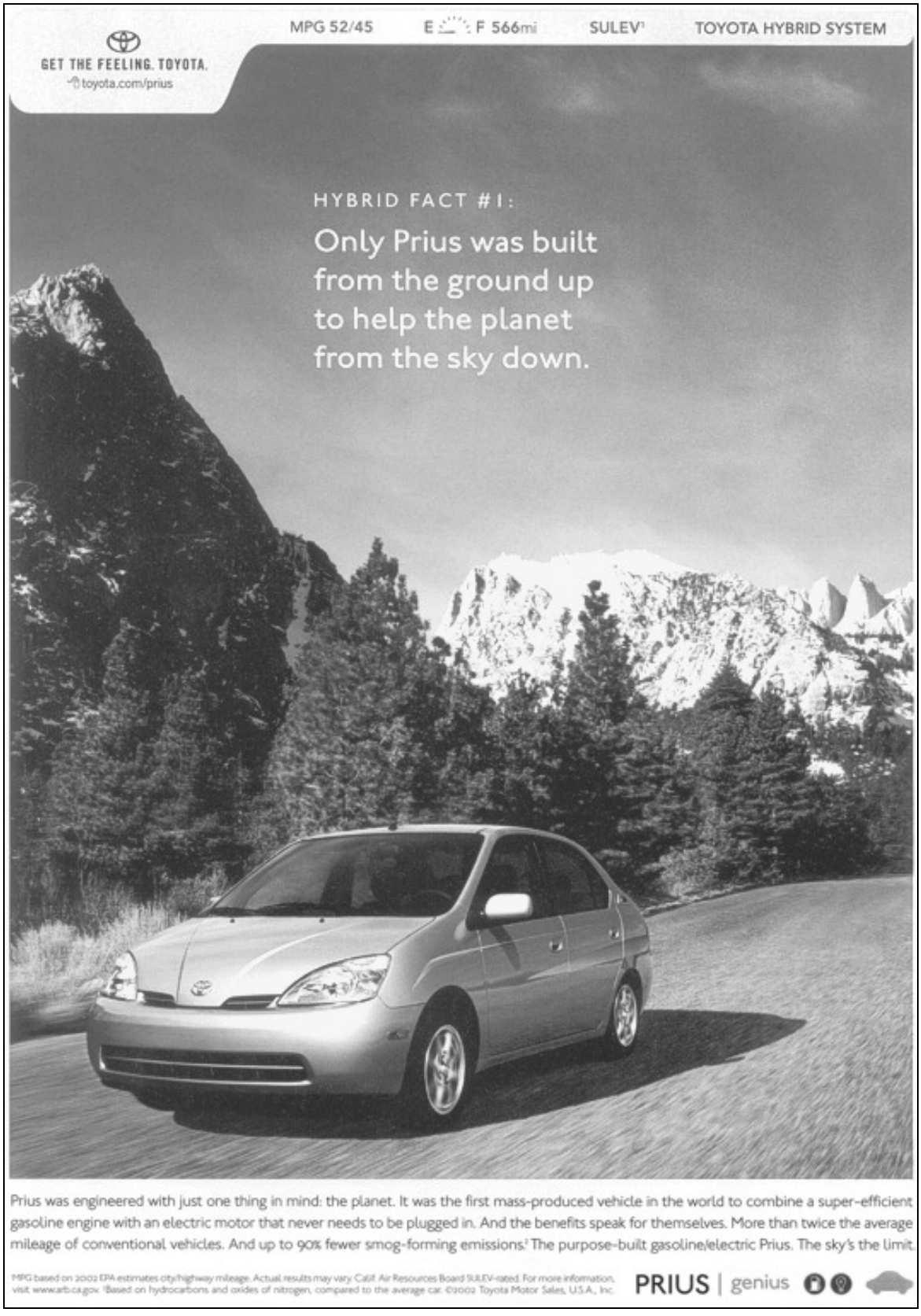
3.5.6 Implications for Marketing Technologies that could reduce GHG Emissions

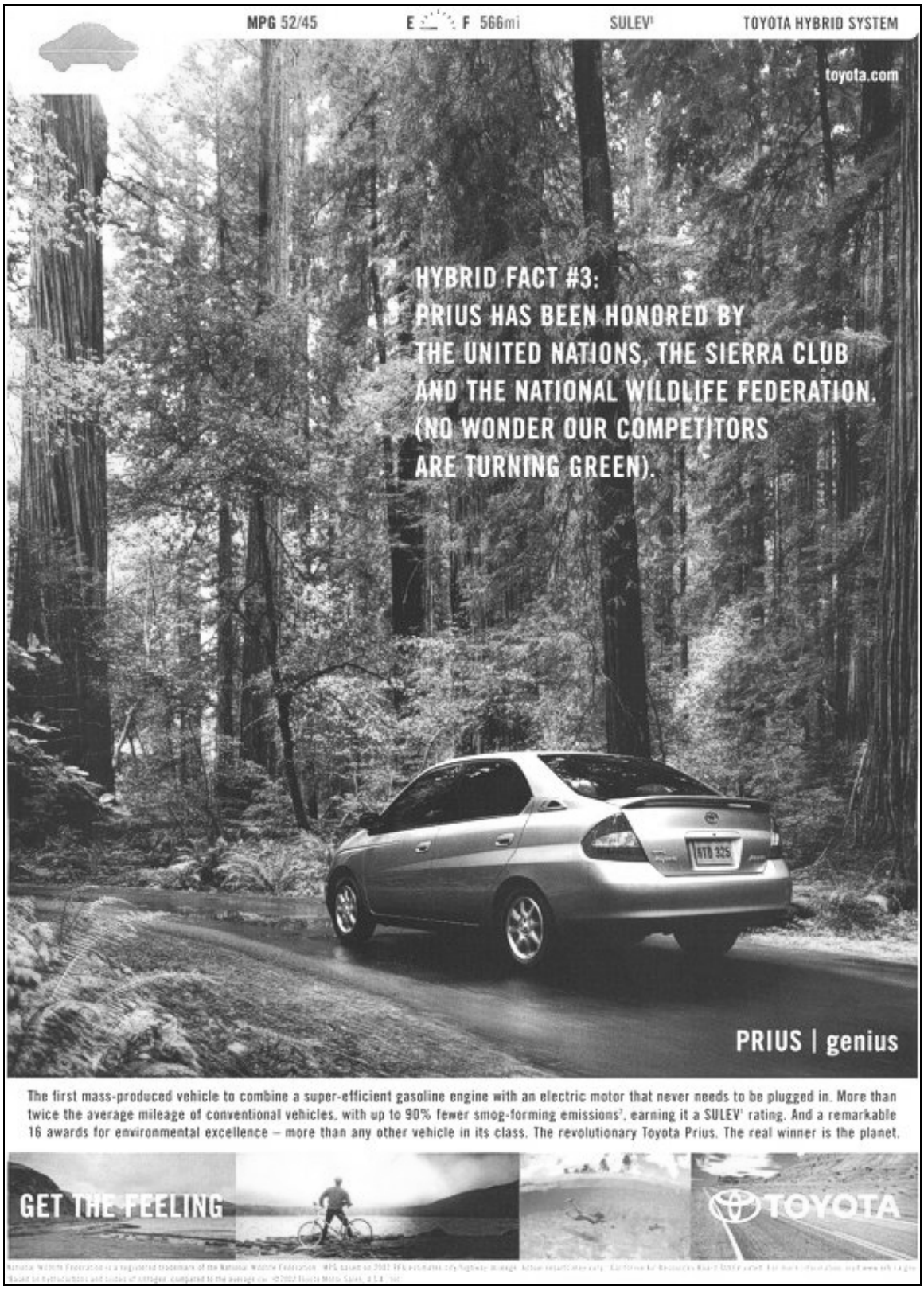
Just as automakers effectively marketed safety and airbags, they can market technologies and models that reduce greenhouse gas emissions. Currently, there is no greenhouse gas legislation in place, but some automakers are already voluntarily marketing technologies that could play a significant role in response to future regulation.

Volkswagen, for example, launched an advertising campaign in support of its diesel-powered cars in 2002. The campaign, which consisted of print ads and 30-second TV commercials, was the first of its kind since the company reintroduced diesels into the American market six years earlier. The advertisements touted the vehicles TDI engine and low fuel consumption, but do not reveal that TDI stands for Turbo Diesel Injection.[72] VW must have felt that promoting the fuel economy improvement that the technology created was a more effective strategy than marketing the technology itself. This strategy is also likely an attempt to enhance the reputation of diesel engines in the US passenger vehicle market.

Hybrid electric vehicle technology has also been marketed relatively extensively during the advanced technology's early entrance into the marketplace. While both Toyota and Honda offered HEVs in the early years of this decade, Toyota has marketed its Prius much more aggressively than Honda has its Civic and Insight. For the first two generations of the Prius, there have been no fewer than 12 unique television commercials, clever Internet advertisements and dozens of print ads appearing in an assortment of well-read periodicals (See Figures 3-7 and 3-8 for example). The ads consistently tout the technology and the environmental friendliness (high fuel economy and low emissions) resulting from the hybrid system, in addition to typical selling points such as comfort and convenience attributes. The ads for the second generation Prius have stressed 'private good' features to a greater extent than those of the previous generation, but have maintained the importance of the 'public good' attributes at the same time. This may signify a shift in the target population from a niche market of early-adopters and technology enthusiasts to a more general, much larger market base. Ernest Bastien, marketing manager for Toyota Motor Sales USA, has confirmed that Prius advertising will be aimed at general audiences, not just environmental activists and technology buffs.[73] The verdict is still out on the question of consumer acceptance of environmentally friendly vehicles. "It's too complicated right now for (consumers) to understand," said the senior automotive analyst for Forrester Research, Mark Bünger. "I hope we'll get a better branding of the vehicles, à la Energy Star or Intel Inside – some real simple stamp that will tell people they're getting a good thing."[74] The Toyota Prius advertising has focused its attention on developing a simple branding to help identify the environmentally-friendly cars in the cluttered new car marketplace.

Figure 3-7 First Generation Toyota Prius Ads (c. 2000)




MPG 52/45
E F 566mi
SULEV[1]
TOYOTA HYBRID SYSTEM
toyota.com
HYBRID FACT #3:
PRIUS HAS BEEN HONORED BY
THE UNITED NATIONS, THE SIERRA CLUB
AND THE NATIONAL WILDLIFE FEDERATION.
(NO WONDER OUR COMPETITORS
ARE TURNING GREEN).
PRIUS | genius
The first mass-produced vehicle to combine a super-efficient gasoline engine with an electric motor that never needs to be plugged in. More than twice the average mileage of conventional vehicles, with up to 90% fewer smog-forming emissions[2], earning it a SULEV[1] rating. And a remarkable 16 awards for environmental excellence – more than any other vehicle in its class. The revolutionary Toyota Prius. The real winner is the planet.
GET THE FEELING
TOYOTA

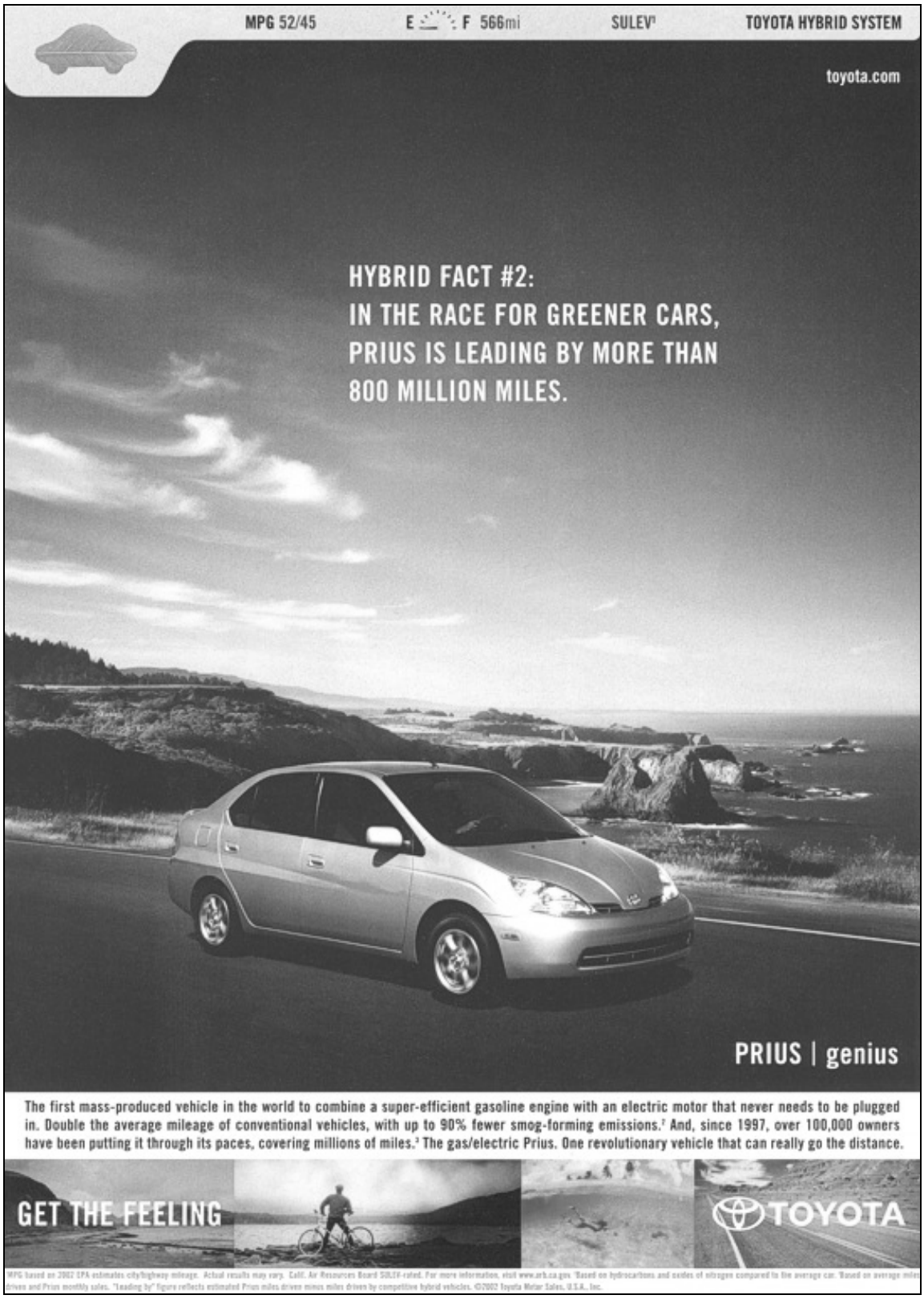
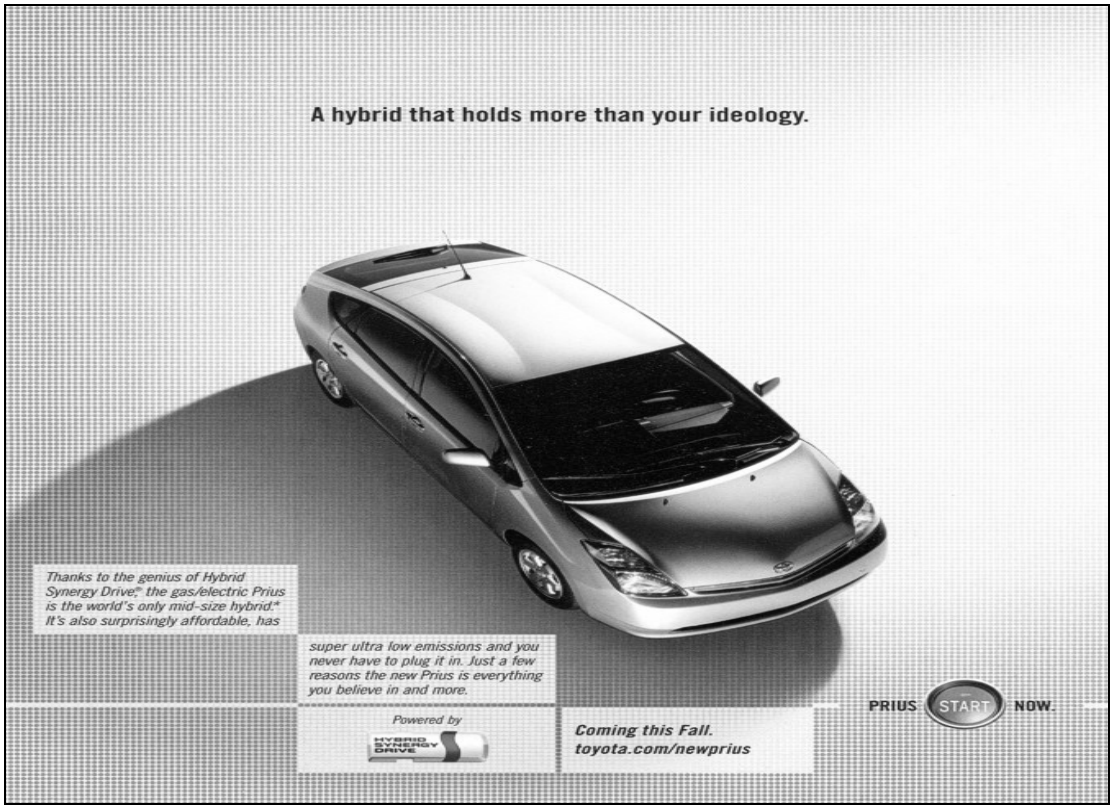
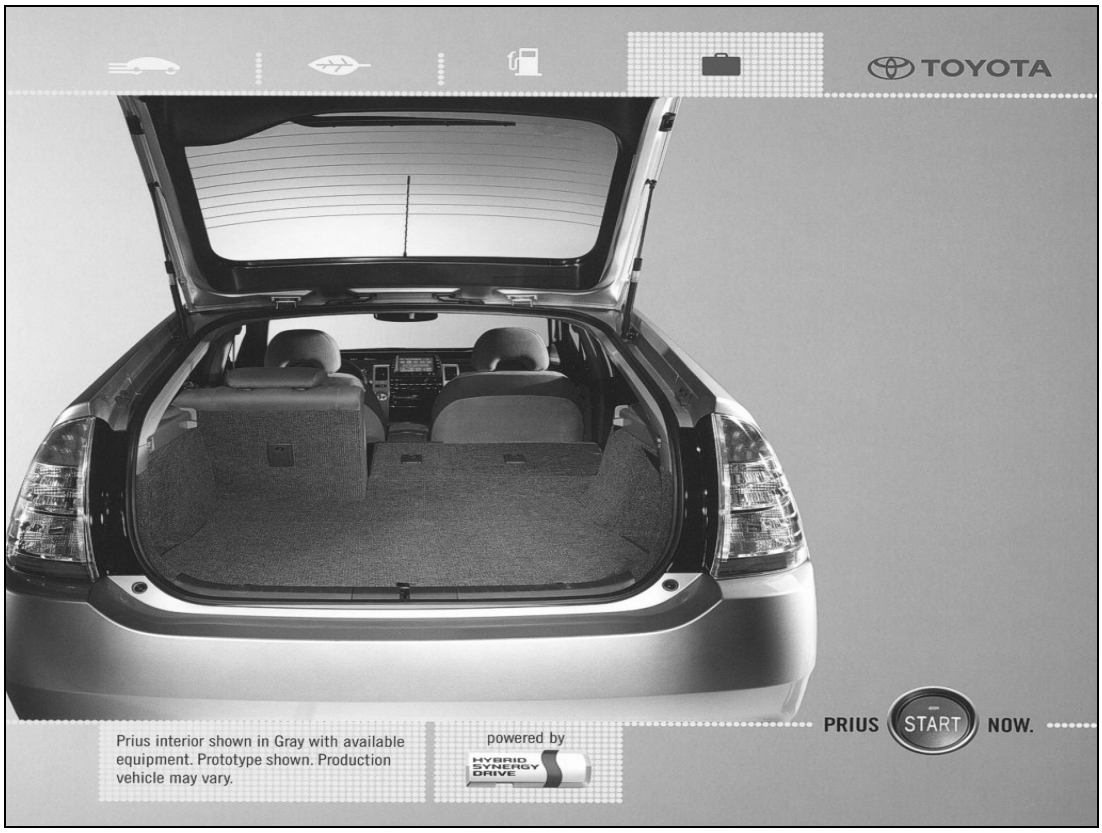

MPG 52/45
E F 566mi
SULEV
TOYOTA HYBRID SYSTEM
toyota.com
HYBRID FACT #2:
IN THE RACE FOR GREENER CARS,
PRIUS IS LEADING BY MORE THAN
800 MILLION MILES.
PRIUS | genius
The first mass-produced vehicle in the world to combine a super-efficient gasoline engine with an electric motor that never needs to be plugged in. Double the average mileage of conventional vehicles, with up to 90% fewer smog-forming emissions.[1] And, since 1997, over 100,000 owners have been putting it through its paces, covering millions of miles.[3] The gas/electric Prius. One revolutionary vehicle that can really go the distance.
GET THE FEELING
TOYOTA

Figure 3-8 Second Generation Prius Ads (c. 2003)





Introducing high performance technology that's also good for the environment.

In the race for a greener planet, Toyota is determined to win. That's why we've developed Hybrid Synergy Drive,* a revolutionary power train that combines a gasoline engine with a powerful electric motor that never needs to be plugged in.

The result? Super-efficient, super-charged performance.

Hybrid Synergy Drive achieves nearly 2.5 times the average fuel efficiency of conventional vehicles and close to 90% fewer smog-forming emissions – all while dramatically boosting power.* In fact, Hybrid Synergy Drive can inject a V6 SUV with the power and torque of a V8.

This groundbreaking yet affordable technology will hit the roads this fall in the next generation Prius. After that, Hybrid Synergy Drive will be available in more and more Toyota products. Welcome to a new era in driving – we're off and racing.

toyota.com/tomorrow *Manufacturer's testing for 2004 est. city & combined mpg. ©2003

HYBRID SYNERGY DRIVE

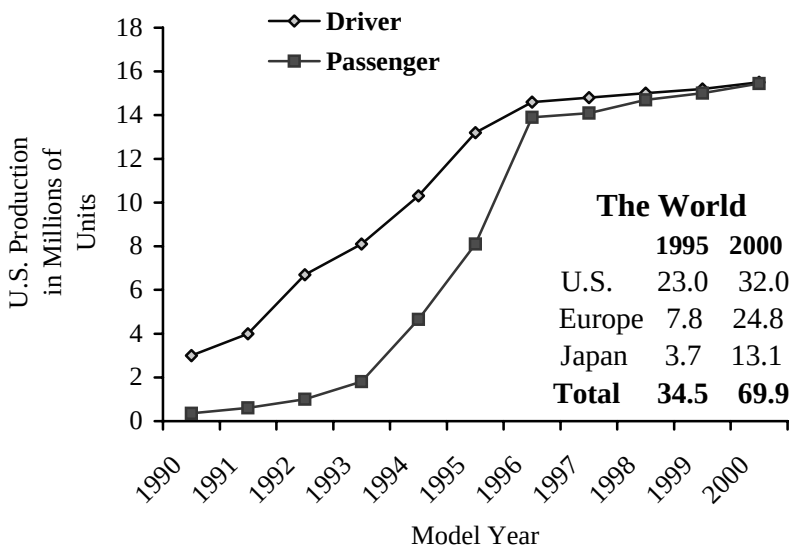
TODAY TOMORROW **TOYOTA**

3.6 BUSINESS, JOB, WEALTH CREATION RESULTING FROM COMPLIANCE

3.6.1 Expansion of the Automotive Airbag Industry

The years following the legislation requiring airbags have been very active ones for the occupant restraints industry. Figure 3-9 highlights the growth of the airbag industry in the decade of the 1990s. Figure 3-9 also shows how the rapid growth in airbag production at home led to swift growth abroad where no such occupant regulations were in effect. There were slightly over 2 million driver and passenger frontal airbag units combined on 1990 model year cars sold in the U.S., and by the 1998 model year when the regulation became fully enacted, there were roughly 18 million dual airbag units.

Figure 3-9 Growth in Airbag Production in Millions (1990 to 2000)



Source: Ward's Automotive Yearbook (Various Years)

Several major airbag companies have merged with or acquired other key participants, resulting in a consolidation of the industry. Allied Signal sold its seatbelt and airbag division to BREED in 1997. As a result, BREED now competes in the occupant restraints market as a supplier of inflators, cushions, airbag modules, collision sensors, electronic control units, occupant sensing systems, steering wheels, seats and seatbelt systems. Magna competed in the occupant restraints industry through MST Automotive, and produced inflators, airbag modules, steering wheels, and seatbelt systems. Early in 1998, TRW purchased from Magna all remaining equity in the MST operations, making it a fully owned division of TRW. Morton International competed in the industry through the Automotive Safety Products division (APS), and was a leading supplier of inflators, modules, and cushions. On May 1, 1997, Morton sold its Automotive Safety Products division to Autoliv AB to form a new company, Autoliv, Inc. In purchasing the ASP division of Morton, Autoliv is now the leading supplier of airbag inflators in the world. Autoliv AB had formed in 1991 through the merger of

Europe's leading automotive safety company and the leading airbag company at the time in the U.S. Table 3-12 shows the current global and domestic situations respectively for the largest airbag suppliers. While the airbag industry is very much a global business, the domestic industry has grown tremendously as well. Three of the top five airbag suppliers (TRW, Delphi, and Breed) are located in the U.S. Takata is based out of Japan, but has major American operations, as does Autoliv.

Table 3-12 Shares in the Global and US automotive safety equip. markets, 2000 (US$ market value)

	Domestic		**Global**	
Manufacturer	**Seatbelts (%)**	**Airbags (%)**	**Seatbelts (%)**	**Airbags (%)**
TRW	40	30	29	26
Autoliv (inc NSK)	12	33	30	35
Takata	15	5	17	15
Delphi	0	17	0	11
Breed	25	6	14	4
Others	8	9	10	9
Total	100	100	100	100

Sources: www.just-auto.com and industry estimates

As shown in the tables, Autoliv controls the largest percentage of both the US and global airbag markets. Financial information for Autoliv in the form of SEC 10-K filings and annual company reports was available to a much greater extent than all of the other major airbag suppliers other than Delphi, which is a vast company where airbags plays a minor role in the overall company. For this reason, Autoliv was chosen to be more closely analyzed. Autoliv deals exclusively with occupant protection and vehicle safety systems, and airbags are the single most important product the company offers. Table 3-13 shows the tremendous growth of Autoliv during the period of 1993-2002. This table illustrates the creation of a new and important industry, resulting from the regulatory compliance process.

Table 3-13 Summary of the Expansion of Autoliv (Airbag Supplier)

Year	Airbag Sales (Millions USD)	Net Income (Millions USD)	Earnings Per Share	Number of Employees[1]	# Airbag units sold[2]
1993	$164	$16	$0.38	4,405	-
1994	$534	$56	$1.05	5,740	3,100,000
1995	$682	$91	$1.66	6,670	4,920,000
1996[3]	$2,287	$174	$1.69	9,000	6,100,000
1997	$2,317	$185	$1.81	17,800	20,500,000
1998	$2,417	$188	$1.84	20,700	28,200,000
1999	$2,715	$200	$1.95	22,600	37,000,000
2000	$2,934	$169	$1.67	28,000	43,500,000
2001[4]	$2,817	$48	$0.49	31,800	42,195,000
2002	$3,160	$181	$1.84	34,200	51,000,000

Source: Autoliv Inc., Annual Reports, See: http://www.autoliv.com/appl_alv/Autoliv.nsf/pages/financial_annual
Table Notes: 1- Number of employees globally, The number of US employees in 2002 was nearly 8,000**.** **2** – Total number of airbag assemblages sold including side airbags and curtains. **3** – Autoliv merged with large airbag supplier, Morton, **4 –** Restructuring year due to merger.

The passage below, which describes the company's approach to achieving cost-competitiveness, is taken from the 2002 Autoliv Annual Report.

> The most important action is redesign of our safety systems by introducing, for instance, more cost-efficient inflators in our airbag systems, replacing labor-intensive cut-and-sewn airbag cushions with one-piece-woven airbag cushions, re-sourcing of labor-intensive products in low labor-cost countries, and replacing steel with reinforced plastics in the housings of the airbags. Vertical integration is another effective tool in our cost reduction program. In 1998, for instance, we increased substantially the annual production capacity for airbag initiators at NCS, a supplier which we acquired in 1996.

Figure 3-10 shows that that airbags have fueled Autoliv's large expansion over the last decade. The market for seatbelts has flattened, while the increase in airbags and electronics and the recent introduction of side airbags, have been fueling the expansion of the company.

Figure 3-10 Market by Product for Autoliv (1993-2002)

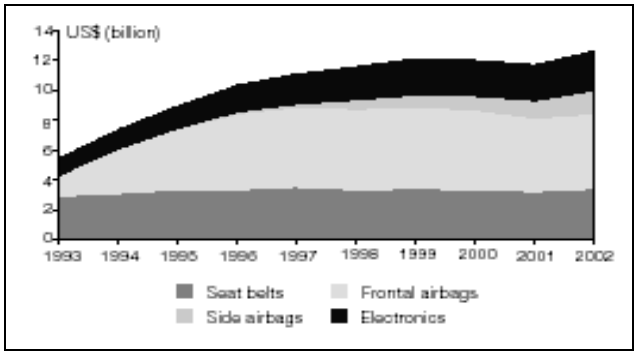
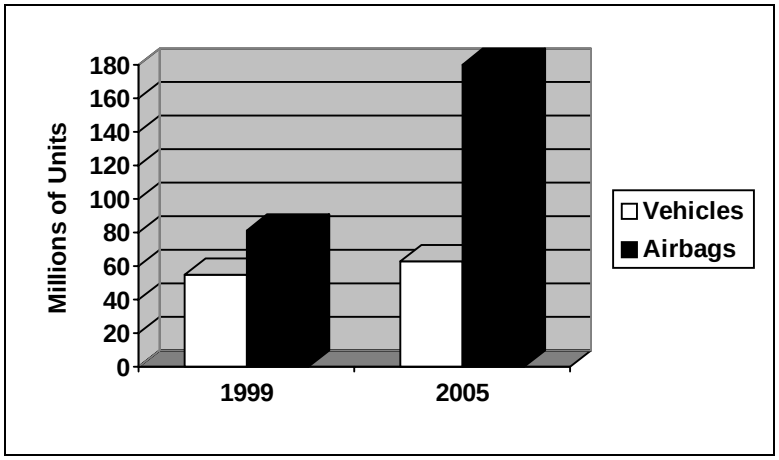


Figure 3-11 indicates the continuing growth in the airbag market. The average number of airbags installed per vehicle is expected to nearly triple between 1999 and 2005 in the global automotive market. As of 2001, the $12 billion vehicle occupant restraint market had grown by an average rate of 12% annually since 1993.[75] While the catalyst behind the initial expansion of the airbag industry was federal safety regulation in the U.S., the continued growth of the industry has relied on consumer demand, improvements in safety technology and innovative new products.

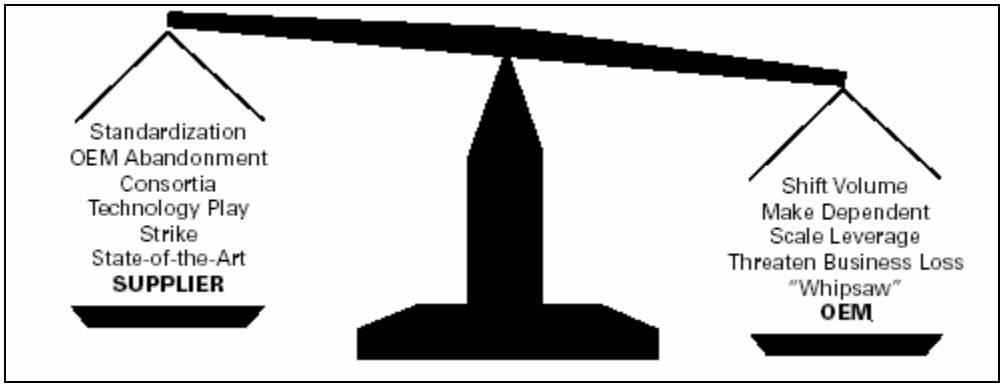
Figure 3-11 Global Outlook for Airbag Industry (1999-2005)



Source: Price Waterhouse Cooper, AUTOFACTS, 2003. http://www.autofacts.com/index.html

Airbag suppliers are held 'captive' by the great purchasing power of the OEMs. The Autoliv 2002 Annual Report states that pricing pressure from their customers, the automakers, is an inherent part of the automotive components business. It was reported that the boom the airbag industry experienced was unlikely to translate into big profits for companies such as TRW, Autoliv, Takata Corp. and Breed Technologies Inc. Morris Kindig, president of the research company Tier One, affirmed that competition and pricing pressure from automaker customers keeps profit margins low. He stated that like most major automotive suppliers, "everyone is really struggling for profitability."[76] The graphic in Figure 3-12 illustrates the balance of power between the OEMs and automotive suppliers.

Figure 3-12 Balance of Power Illustration between OEMs and Suppliers



Source: Ernst & Young, LLP, "Profile of Tomorrow's Automotive Supplier" http://www.autoindustria.com/encuentro/documentos/automotive_supplier_capgemini.pdf

Smaller tier two and tier three suppliers that produce airbag components have also shown rapid growth. For instance, a recent study on the "World Image Sensors Market" from Frost & Sullivan suggests that a growing complementary metal-oxide semiconductor (CMOS) technology market will enhance vehicle safety applications, especially SUV safety, through controlled airbag deployment and collision avoidance systems. The report reveals that the entire image sensor industry generated revenues of $2.4 billion in 2000. Frost & Sullivan projects these revenues to reach $6.5 billion by 2007.[77]

3.6.2 Technological Innovation with respect to Airbags

The research and development expenditures of automakers and suppliers that helped to produce a reliable and cost-competitive safety device were substantial. In response to NHTSA questioning, airbag supplier TRW stated in January 1998 that the company had invested over $1.1 billion ($332 million on R&D alone) in its airbag business over the last decade. According to annual company reports, Autoliv has been spending in the neighborhood of $175-200 million per year on R&D since 1993. Table 3-14 highlights the proliferation in patent issuances since airbag regulation took effect. The former Administrator of NHTSA, Joan Claybrook, summarizes the effect regulation can have on technological innovation in the following passage.

> Regulations, in general, encourage innovation in areas where the market demand is unclear. If manufacturers believe safety does not sell, they will be reluctant to risk innovations in that area, believing they will have a price disadvantage if they do. By levying uniform standards on all companies, this risk is eliminated and the manufacturers are challenged to find the least costly way to achieve the performance required.[78]

Claybrook contends that federal emissions, fuel economy and safety standards have stimulated not only product innovation, but have advanced the art of automotive engineering as well. The number of patents is typically used as a proxy measure for technological innovation. Table 3-14 shows that out of the nearly 10,000 automotive airbag relevant patents, over 70% of these have been issued since 1995, and the rate appears to have been accelerating through 2000. Clearly, the primary driver for such a

rapid upsurge in airbag technology development was the passive restraint regulation. The regulation provided the impetus that created the initial market.

One of the best examples of successful "technology forcing" regulation involved automotive emission control technologies. The two most glaring technologies to come out of these strict regulations were the simple oxidation catalysts and the closed loop, three-way catalysts with sophisticated on-board feedback control systems, but innovative technologies have continued to meet requirements such as the SULEV and PZEV standards in California, and the National Low Emission Vehicle Program (NLEV) nationwide. Technologies were developed to meet the stringent requirements although automakers were initially pessimistic toward the possibility of even achieving compliance. Lee Iacocca and other industry executives asserted that the 90% emissions reduction requirement "could prevent continued production of automobiles" and "do irreparable damage to the American economy."[79] Figure 3-13 depicts the relationship between the number of patents for automotive emission control technologies and the stringency of emissions regulations

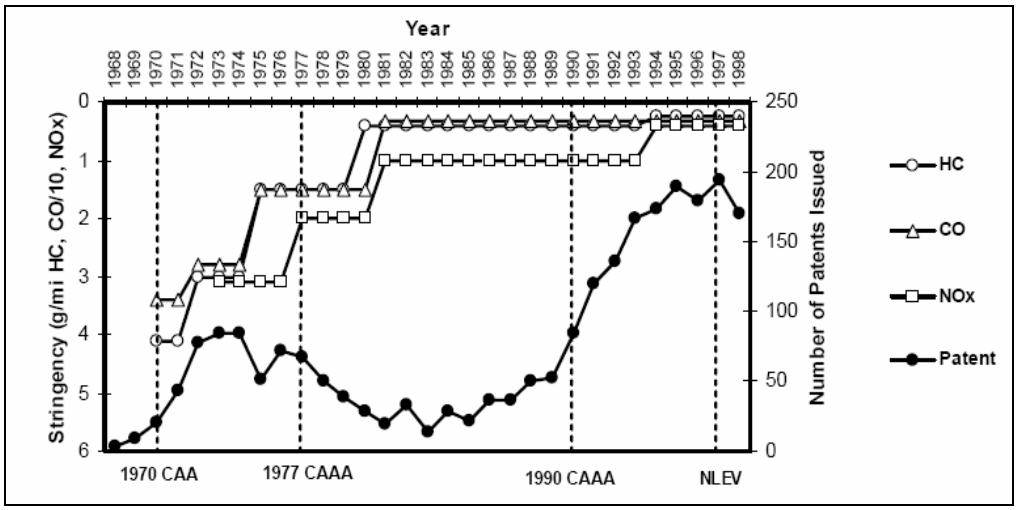
Table 3-14 Relevant patents issued for automotive airbag technology

Patent Subclass	Pre-1980	1980-1989	1990-1994	1995-1999	2000-present	Total
728.1	20	14	58	177	208	**477**
728.2	7	5	96	374	317	**799**
728.3	9	11	117	285	228	**650**
729	33	9	12	43	117	**214**
730.1	48	6	39	110	129	**332**
730.2	4	2	30	196	356	**588**
731	55	32	142	245	206	**680**
732	39	14	161	289	190	**693**
733	51	11	23	33	82	**200**
734	65	25	50	70	76	**286**
735	140	46	179	400	542	**1307**
736	51	18	95	191	205	**560**
737	81	10	43	169	109	**412**
738	26	3	19	22	10	**80**
739	30	7	25	67	66	**195**
740	46	11	44	96	88	**285**
741	90	31	118	357	255	**851**
742	32	6	35	71	126	**270**
743.1	38	7	88	261	283	**677**
743.2	6	2	19	60	105	**192**
Total	**871**	**270**	**1393**	**3516**	**3698**	**9748**

Table Notes: Data compiled from US Patent and Trademark Office, See: http://www.uspto.gov/. The patent subclasses are all under Class 280 – Land Vehicles. A description of the patent subclasses is offered in Appendix E.

In the case of the airbags, some researchers contend that the behavior of the OEMs and airbag suppliers suggests that competition to meet the expected regulatory standard, not competition to satisfy consumer demand, was the primary driver of R&D and innovation with respect to airbag technology.[80] The emissions control and passive restraint regulatory episodes were not driven by differences in costs or complexity of the technological solutions.[80] GM installed airbags on several thousand vehicles in 1973, illustrating that the technology was workable. GM also offered airbags on a number of models between 1974 and 1976, at a price of $235-$315. Field results from these cars and a fleet of Mercurys operated by State Farm Insurance performed well. However, by the end of the decade no automaker was producing airbag-equipped vehicles. In contrast, GM and Ford each put catalytic converters on their vehicles in 1975 at a unit cost of roughly $250 per vehicle, and by the end of the decade virtually all automobiles sold in the U.S. employed catalyst technologies. Clearly, it was the necessity of compliance that assured the adoption of innovative technologies. In the airbag case, the market and the numerous accompanying innovations emerged after regulation signaled the need for airbag technology. The continued path of innovation has been fueled by a combination of both consumer demand and regulation for advanced airbags and airbag systems in general in other countries.

Figure 3-13 Patenting Activities in Automotive Emission Control Technologies, 1968 to 1998



Source: Lee, Jaegul, et al. "Innovation in Automotive Emission Control Technologies: Government Actions, Inventive Activity, and Learning," Proceedings on 7th International Conference on Technology Policy and Innovation, Monterrey, Mexico

3.7 UNREGULATED AUTOMOTIVE SAFETY SYSTEMS

A host of other safety technologies emerged around the time frontal airbags became a fixture in new vehicles. A look at three prominent examples of these technologies will help to place airbags in the overall context of vehicle safety attributes. ABS, traction control and side airbags are the other high-profile safety devices that have been available as optional or standard equipment during, or shortly after, frontal airbags. ABS and traction control are active safety features, while side airbags and airbags in general are considered passive safety features (See Table 3-15 for examples).

Table 3-15 Examples of Active and Passive Safety Attributes

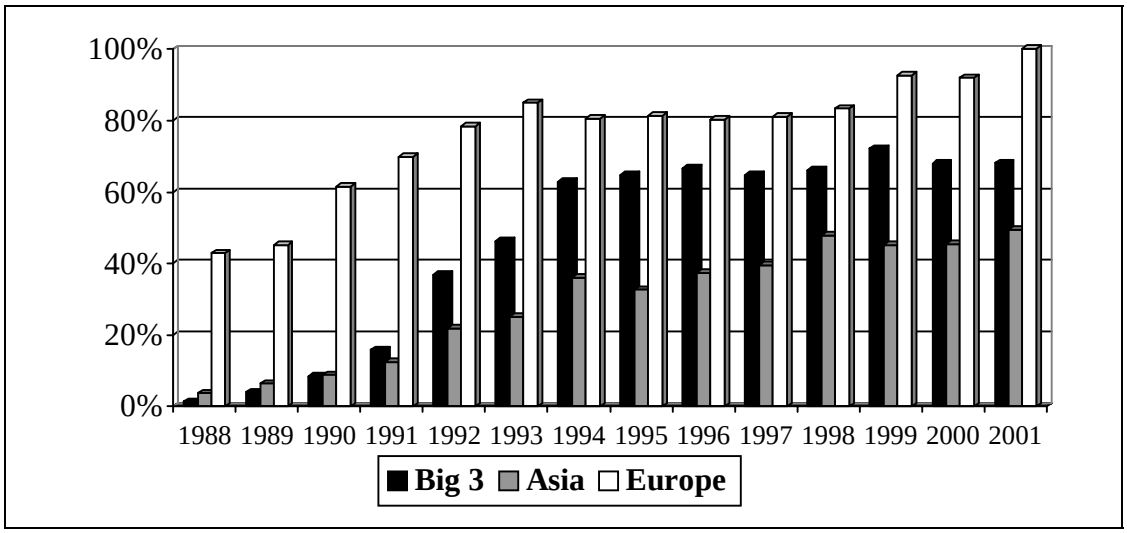
ACTIVE SAFETY FEATURES (CRASH AVOIDANCE)	PASSIVE SAFETY FEATURES (CRASH WORTHINESS)
Traction Control	Energy Absorbing Structure
Mirror Systems	Hood Latch Systems
Yaw Control Systems	Side Impact Door Structure
Headlamp Lighting Systems	Fuel System Integrity
Visibility	Safety Cage Occupant Compartment
Vehicle Lighting Systems	Interior Impact Protection
Displays & Controls	Compressible Steering Column
Anti-Lock Brakes Systems	Child Restraint Systems
Speed Sensitive Steering Systems	Seat Systems
Adaptive Suspension System	Safety Glazing Systems
Brake Systems	Adjustable Safety Belt Anchorages
Wheel & Tire Systems	3-Point Safety Belts
Wiper/Washer	Locks and Latches
	Load Limiting Safety Belts
	Safety Belt Pretensioner
	Head Restraints

3.7.1 Anti-Lock Braking Systems (ABS)

ABS were originally developed for trains in the early 1900s, and were then adopted by jet aircraft, which demand fast, controlled braking, after World War II.[81] ABS were generally considered to be costlier than airbag systems. While ABS became standard on most luxury cars, particularly European models, as far back as the 1980s, it was GM that pioneered the system's inclusion across an entire vehicle line. The installation rate on GM cars hovered between 80-90% from 1994 to 2001, but GM in a cost-cutting effort eliminated standard ABS and side airbags from most of its vehicles beginning with the 2003 model year. According to GM, ABS, at that time, cost the

company about $160 per vehicle, and side airbags were an additional $60.[82] GM had obtained a competitive advantage over its competitors in the early 1990s with its ABS VI system designed by the firm's Delco Chassis Division. Delco engineers through design improvements and other cost-saving measures produced a relatively inexpensive system that could be made standard on even the company's economy cars. Experts at the time predicted that ABS, fueled by consumer demand, would be made standard on almost all cars before the decade was through. According to Figure 3-14 this was true only for the European automakers with the Big Three having leveled off at less than 70%, and Japanese automakers currently installing ABS on only about ½ of the cars they sell in the U.S. Currently, the average cost to consumers for ABS is about $470.[83]

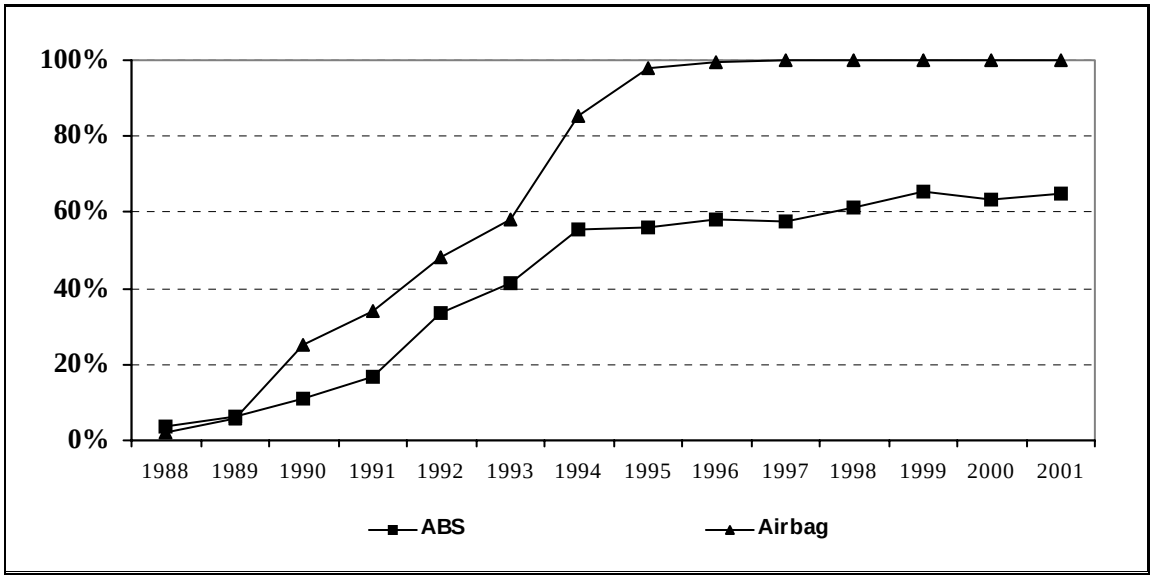
Figure 3-14 Anti-Lock Braking System Installation Rates on Cars Sold in the U.S.



Source: Ward's Automotive Yearbook (Various Years)

Without regulation, would the installation rates for airbags be even with ABS, or more or less? The question cannot be answered with any degree of certainty, but across the board 100% installation rates most likely wouldn't have been achieved without regulations. Figure 3-15 shows the respective installation rates of airbags and ABS on passenger cars sold in the U.S.

Figure 3-15 ABS and Airbag Installation Rates on Passenger Cars Sold in the U.S.

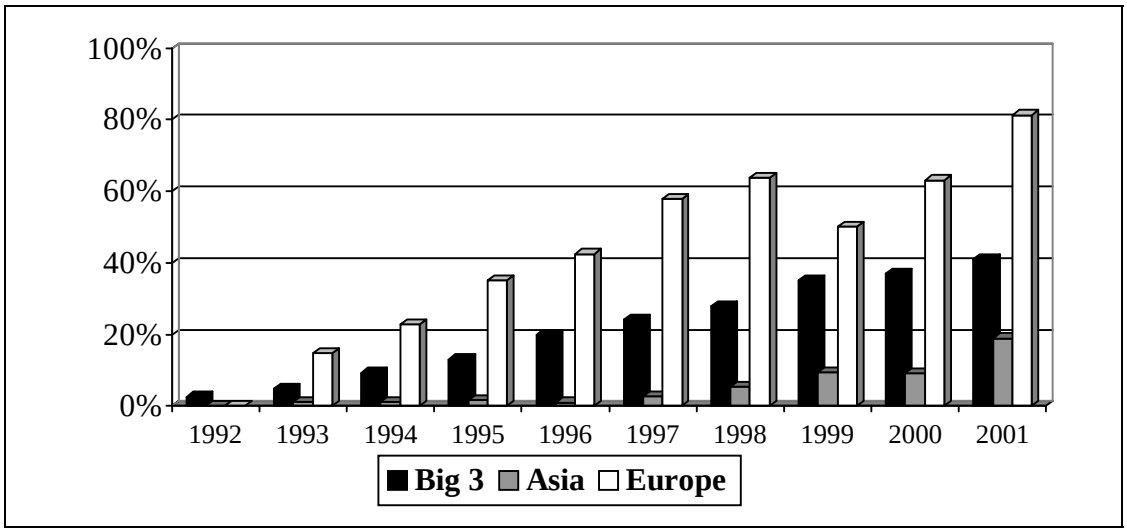


Source: Ward's Automotive Yearbook (Various Years)

3.7.2 Traction Control

Traction control works to prevent unwanted wheel spin in low-traction situations such as snow or rain by adjusting vehicle acceleration. The system maintains the car's *steerability* by detecting when a tire has little traction and then correcting the wheel spin by slowing the wheel's movement.[84] This attribute, like most safety features, has become increasingly popular over the last ten years. The demand for traction control systems is driven entirely by consumer demand with regulatory pressure playing no role in its success. The average cost to consumers for a typical traction control system is currently about $220.[83] Figure 3-16 shows how rapidly traction control systems have penetrated into the U.S. passenger car market.

Figure 3-16 Traction Control Installation Rates on Cars Sold in the U.S.

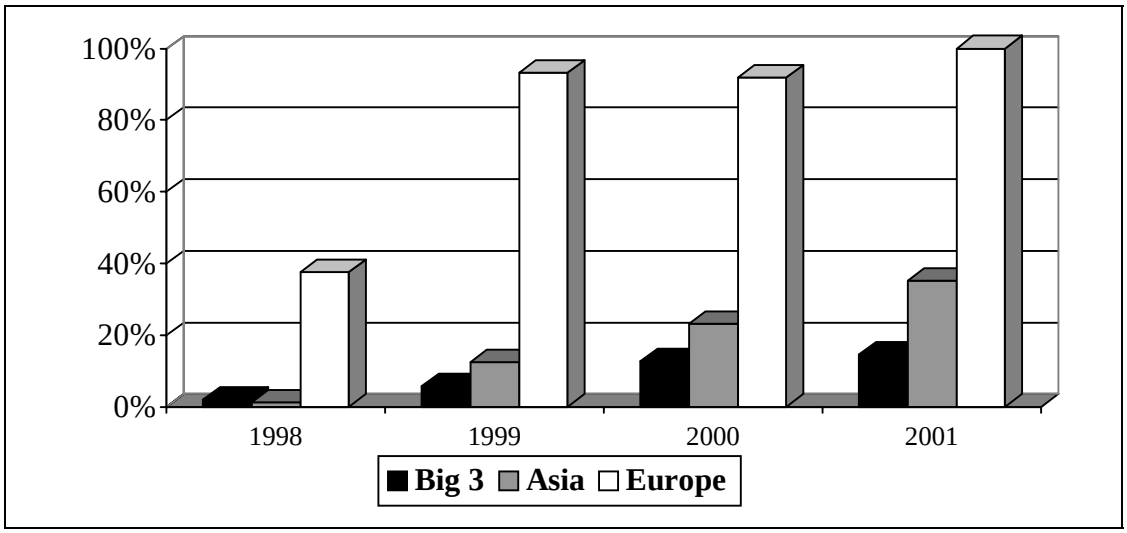


Source: Ward's Automotive Yearbook (Various Years)

3.7.3 Side Airbags

The installation of side airbags has risen steadily over the last few years. There is currently no regulation that calls for side airbags, but the side crash test requirements have become increasingly stringent. Much of the airbag industry's future growth rests with alternative airbag systems such as side and curtain (head) systems. Although there is no direct regulatory pressure to include side airbags, independent agencies that have an influence on vehicle content (e.g. NHTSA and IIHS) could initiate action if automakers fail to take initiative.[33] Safety attributes are among the most highly valued in a vehicle, which facilitates the whole process. There is a large divide between consumers that want safety features and those who are willing to pay for it, though. One industry official quoted the difference to be 85% who value safety features highly, but only 15% are willing to pay for it, which depending on the interpretation may validate the need for safety regulation. The average consumer cost of side airbag systems today is in the neighborhood of $330.[83] Figure 3-17 highlights the burgeoning side airbag market in the U.S.

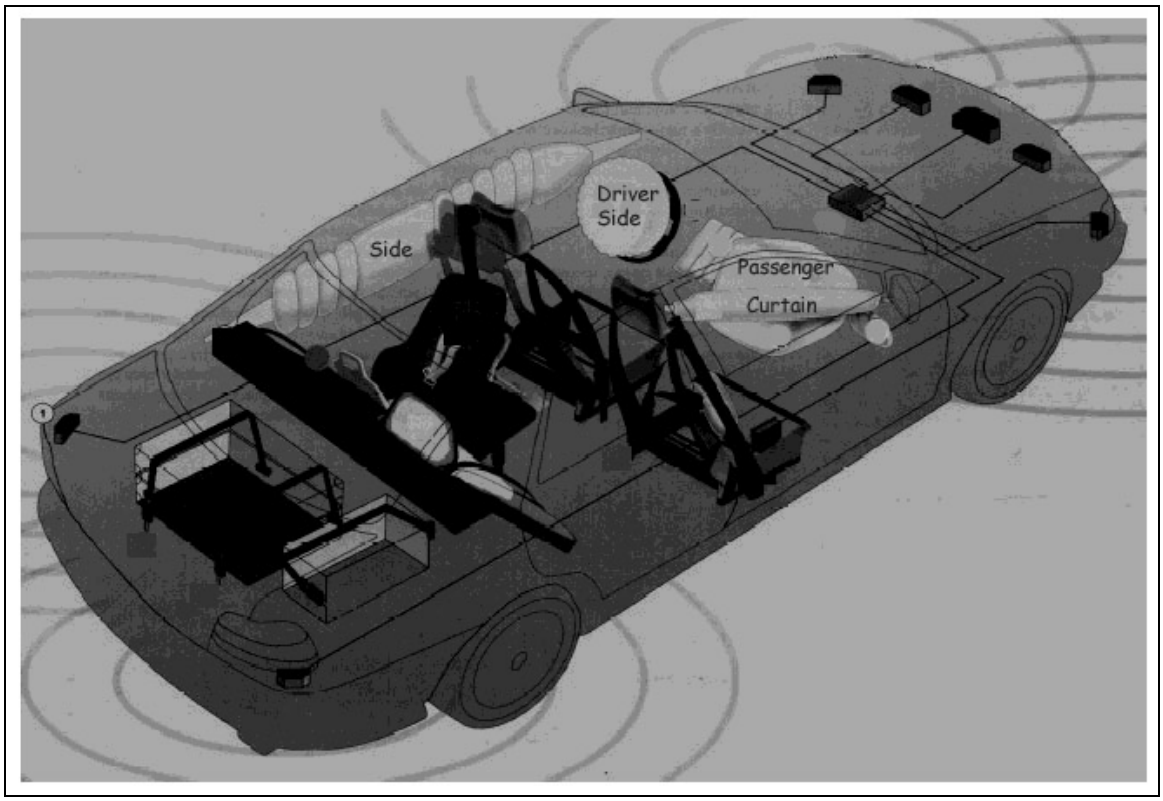
Figure 3-17 Side Airbag Installation Rates on Cars Sold in the U.S.



Source: Ward's Automotive Yearbook (Various Years)

The trend toward more safety content on vehicles has accelerated since the adoption of the passive restraint standard. The tendency has been for automakers to introduce safety features such as side and curtain airbags in luxury models first and then follow-up after a few years by including them on standard vehicles. For example, side airbag systems were typically included in Lexus, Acura, Infiniti, Audi, Cadillac, and Lincoln models one to three years before showing up in significant numbers on Toyota, Honda, Nissan, VW, GM, and Ford models. Figure 3-18 depicts the various airbag systems on a current production car.

Figure 3-18 Diagram of Modern Airbag Systems



Source: Adapted from a diagram as presented by Gerber Technology, http://www.gerbertechnology.com/. The black boxes near the front bumper of the vehicle are sensors, which are connected via wiring to the information hub, the control module. As discussed earlier the industry trend has been to move toward the use of one sensor to discern front impact crashes.

4 CONSUMER RESPONSE

The industry response to the eventual airbag regulation was well documented in the previous section, but how did consumers respond? Along with costs and product liability concerns, consumer acceptance of the safety devices had been cited as one of the major barriers to the adoption of an airbag standard. This concern may have also made the government more receptive to alternative strategies that addressed the problem areas in occupant crash protection.

4.1 Impact of Compliance-Related Vehicle Attribute Changes and Accompanying Price Changes on New Car Sales

The regulation requiring the inclusion of airbags on all vehicles appears to have had little impact on vehicle sales or sales mix. The dramatic sales shift away from passenger cars toward light trucks (particularly SUVs) was a phenomenon that coincidentally occurred during the same timeframe of the airbag requirement. Airbags were required in all light trucks only one year after a 100% requirement for passenger cars went into effect, suggesting the strong move toward SUVs had nothing to do with airbags. As Table 4-1 shows, there was also a significant sales mix change in favor of midsize cars at the expense of smaller cars. This may be partly attributable to a greater emphasis on vehicle safety, but other causes such as generally low fuel prices and consumer preferences for midsize cars play a large role.

Table 4-1 Percentage of Passenger Cars and Light Trucks Sold in the U.S. (1987-1997)

Model Year	*Passenger Cars*					*Light Trucks*							
	Sales (000)	Frac	Vehicle Size			Sales (000) Small	Frac	Vehicle Size			Vehicle Type		
			Small	Mid	Large			Small	Mid	Large	Van	SUV	Pickup
1987	10731	72.2%	63.5	24.3	12.2	4134	27.8%	19.9	59.6	20.6	26.9	21.1	51.9
1988	10736	70.2%	64.8	22.3	12.8	4559	29.8%	15	57.2	27.8	24.8	21.2	53.9
1989	10018	69.3%	58.3	28.2	13.5	4435	30.7%	13.9	58.9	27.2	28.8	20.9	50.3
1990	8810	69.8%	58.6	28.7	12.8	3805	30.2%	13.4	57.1	29.6	33.2	18.6	48.2
1991	8524	67.8%	61.5	26.2	12.3	4049	32.2%	11.4	67.2	21.4	25.5	27	47.4
1992	8108	66.6%	56.5	27.8	15.6	4064	33.4%	10.4	64	25.6	30	24.7	45.3
1993	8457	64.0%	57.2	29.5	13.3	4754	36.0%	8.8	65.3	25.9	30.3	27.6	42.1
1994	8414	60.2%	58.5	26.1	15.4	5572	39.8%	9.8	62.5	27.7	25	28.5	46.5
1995	9396	62.0%	57.3	28.6	14	5749	38.0%	8.6	63.5	27.9	28.9	31.6	39.5
1996	7890	60.0%	54.3	32	13.6	5254	40.0%	6.5	67.1	26.4	26.8	36	37.2
1997	8335	57.7%	55.1	30.6	14.3	6117	42.3%	10.1	52.5	37.3	20.7	40	39.3
1998	7972	55.2%	49.4	39.1	11.4	6477	44.8%	8.9	58.7	32.4	23	39.8	37.3

Source: Hellman and Heavenrich (2003) *Light-duty Automotive Technology and Fuel Economy Trends 1975 through 2003*, Report EPA.

By looking at how the sales of individual car models are affected when airbags are made standard, we can begin to understand consumer reaction to airbags. The change in sales between the years when an airbag is not available and when it becomes standard helps show how consumers responded to the airbag and its added cost. Table 4-2 shows that for the most part sales went up when airbags were added, even as the MSRP increased at an above average rate. When airbags were added, the average change in sales only goes down for luxury and sports cars and for Asian automakers.

When neither airbags nor ABS are made standard on a new car, which is the baseline case, average sales decrease in all categories except one: European automakers. The case of ABS falls somewhere between the baseline and airbag cases. Sales of European and Asian vehicles increased when ABS was added, while Big 3 average sales decreased. Compact, large and luxury cars dropped in average sales, while midsize and

sports cars increased on average. Adding either airbags or ABS adds cost on average, which should depress sales, but the data on sales do not support this. The additional cost was not associated with lowered sales.

These findings are suggestive, not definitive. The sample sizes for the groups of individual car models used for this analysis are generally small, and other factors may be more instrumental. In any case, the addition of airbags on cars clearly was associated with increased sales.

Table 4-2 Annual Aggregate Sales and Price Changes (All, Region, Vehicle Class)

Break Variable Safety/Year/ Region/Vehicle Class		Number n	Δ Sales		Δ MSRP 2002$		Δ MSRP Current$	
			Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Safety Feature	1 Airbag	195	**1,042**	18,403	**$746**	$2,139	**$1,112**	$2,052
	2 Airbag	25	**831**	23,200	**$669**	$951	**$1,109**	$974
	ABS	50	**-1,377**	22,440	**$1,105**	$1,430	**$1,460**	$1,339
	Traction	44	**4,790**	13,962	**$341**	$1,993	**$630**	$2,265
Year	1989	103	**-6,287**	21,472	**$704**	$1,065	**$940**	$1,013
	1990	109	**-8,499**	24,116	**$378**	$2,331	**$613**	$2,084
	1991	117	**-9,078**	15,437	**$217**	$1,029	**$840**	$1,137
	1992	122	**-2,225**	16,224	**$797**	$2,594	**$1,237**	$2,617
	1993	121	**268**	14,990	**$426**	$1,963	**$900**	$1,829
	1994	115	**4,106**	21,912	**$605**	$1,416	**$1,340**	$1,523
	1995	105	**-2,916**	18,620	**$258**	$2,125	**$803**	$2,037
	1996	110	**-255**	18,640	**$363**	$945	**$806**	$1,097
	1997	113	**-1,520**	12,713	**$287**	$1,499	**$359**	$1,518
	1998	106	**-1,502**	20,402	**$466**	$1,661	**$314**	$1,570
	1999	100	**3,623**	17,513	**$519**	$999	**$339**	$956
	2000	101	**-1,523**	25,579	**$402**	$1,880	**$396**	$1,903
	2001	103	**-5,154**	13,323	**$643**	$1,707	**$517**	$1,719
	2002	97	**-865**	14,612	**$945**	$1,263	**$620**	$1,149
Big3	All	726	**-4,769**	23,534	**$446**	$1,063	**$665**	$1,050
	Airbag	99	**1,815**	25,784	**$652**	$1,545	**$1,033**	$1,453
	ABS	29	**-4,219**	27,425	**$1,401**	$1,371	**$1,743**	$1,287
Europe	All	268	**977**	7,968	**$558**	$3,241	**$902**	$3,153
	Airbag	46	**1,995**	8,100	**$841**	$3,361	**$1,265**	$3,067
	ABS	11	**4,023**	17,111	**$646**	$1,491	**$1,004**	$1,303
Asia	All	522	**-402**	14,979	**$541**	$1,181	**$730**	$1,305
	Airbag	74	**-640**	11,822	**$815**	$1,487	**$1,149**	$1,669
	ABS	15	**3,899**	17,423	**$1,167**	$1,383	**$1,427**	$1,299
Com-pact	All	509	**-3,748**	22,790	**$343**	$724	**$484**	$706
	Airbag	60	**410**	22,682	**$391**	$663	**$670**	$654
	ABS	13	**-2,219**	30,815	**$1,011**	$1,108	**$1,281**	$1,031
Mid-size	All	330	**-1,887**	23,958	**$397**	$856	**$603**	$862
	Airbag	47	**4,185**	25,325	**$675**	$756	**$995**	$473
	ABS	14	**3,149**	25,388	**$858**	$818	**$1,253**	$683
Large	All	102	**-3,690**	18,962	**$481**	$817	**$675**	$818
	Airbag	16	**6,360**	18,463	**$964**	$1,010	**$1,322**	$964
	ABS	6	**-4,879**	17,758	**$1,367**	$1,421	**$1,590**	$1,432
Luxury	All	457	**-482**	7,559	**$706**	$2,832	**$1,070**	$2,806
	Airbag	79	**-462**	8,559	**$884**	$3,208	**$1,350**	$3,043
	ABS	12	**-5,410**	10,824	**$1,385**	$2,402	**$1,911**	$2,210
Sports	All	125	**-2,443**	14,804	**$647**	$920	**$862**	$961
	Airbag	18	**-3,474**	19,480	**$1,212**	$1,216	**$1,654**	$1,332
	ABS	5	**2,016**	18,788	**$1,053**	$477	**$1,267**	$566
All	**Total**	**1,523**	**-2,254**	**18,924**	**$498**	**$1,696**	**$729**	**$1,693**

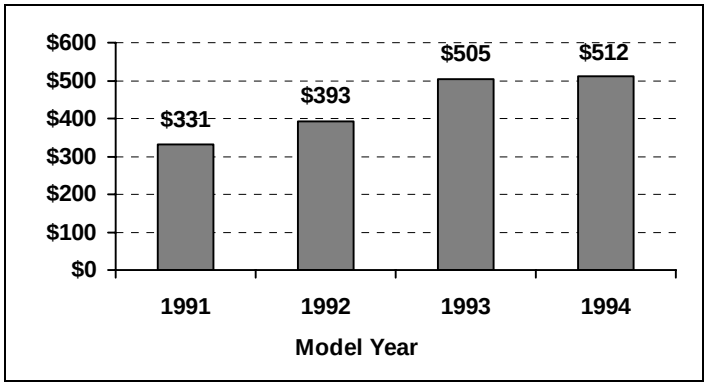
Table Notes: This table represents average annual sales and price changes. The safety feature refers to the average sales and price change when that equipment is made standard. Airbags include driver, passenger and side, and are treated equally (i.e. whether a driver airbag is made standard is treated the same as if a

passenger airbag was made standard on a vehicle that already had a driver airbag, or on a vehicle that had dual airbags, but added side bags. The prices for the airbag systems are not perfectly equivalent, but as shown in the cost section of this report, they are close enough to be treated together in this table.

When analyzing consumer behavior in response to new or modified vehicle attributes and price changes brought about by regulation, there are a great many variables to consider. As mentioned earlier, the adoption of airbags transcended the typical regulation-forcing process, and became at least a partly market-driven phenomenon. Mannering and Winston went so far as to call the adoption of airbags a "rational market outcome," and ultimately the airbag was offered as much by automakers because consumers were willing to pay for it as the federal regulation (see Figure 4-1).[85] This point is certainly debatable, and others, including all of the industry people interviewed for this report, hold the viewpoint that first and foremost, the adoption of airbags was fueled by the regulation, and consumer demand was merely a secondary driver. This trend has continued globally where even countries in South America, for example, are considering some form of airbag regulation. Airbags, unlike emissions control equipment, offer a private as well as a public benefit.

Airbags, and more generally safety systems, have also become an array of attributes that signify status. Sophisticated safety systems first appear on expensive luxury vehicles, and after a period of time some of these technologies may show up on non-luxury models. Non-regulated safety systems such as ABS, traction control, side airbags, and advanced headlamp lighting systems offer not only added safety, but also added status. The regulation of airbags is unique in that it forced automakers to place a technology, which had been appearing primarily on the Mercedes and Porsches, into the most low-priced vehicles.

Figure 4-1 Average Willingness to Pay for a Driver-Side Airbag



Source: Mannering and Winston (1996).

4.2 INCENTIVES TO SPEED UP THE INTRODUCTION OF AIRBAGS

4.2.1 The Insurance Industry

The Insurance industry actively lobbied for airbags throughout the long regulatory deliberation. Insurance companies lobbied for passive restraint regulation to reduce their costs and at the same time improve their public image.[86] While the automakers and auto dealers may have done relatively little to promote airbags at first, the insurance industry played a prominent role. A Texas-based insurer, United Services Automobile Association (USAA), announced in 1988 that it would offer a $300 bonus to policyholders who purchased, or leased long-term, an airbag-equipped car.[87] The Association's chairman, Robert F. McDermott further stated: "USAA is also working with Ford and GM to develop an incentive program – recognition and prizes – for dealerships and individual salespeople who sell cars with optional air bags…for the first time in the industry, we're able to offer incentives to those who sell safety as well as to those who buy it."[88] The prizes included such things as two-week cruises and home video equipment. GM and Ford quickly committed to supporting the incentive program.

A discount in personal injury and medical payment coverage rates was the more typical incentive structure designed to encourage the purchase of the airbag option. USAA initially offered a 30% discount, but doubled it to 60% shortly thereafter. Other big automobile insurers such as State Farm and Nationwide offered discounts of 30-40% to stimulate airbag sales. Allstate Insurance Co. had even offered a 30% discount on medical and no-fault personal injury insurance in 1973 in an attempt to induce consumers to purchase GM's new airbag option.[86] The incentives at that time had little impact on consumer choice.

The impact of insurance incentives between roughly 1988 and 1997 is not well understood. Consumers accepted the regulated technology of airbags and this acceptance was assisted to a certain degree by savings in auto insurance payments to help offset the added cost of the technology. The support of airbags by the insurance industry also gave validity to the safety device, which led to higher consumer confidence and a smoother transition to an airbag-equipped vehicle fleet.

Figure 4-2 Allstate Airbag Advertisement (1975)

The people in these cars walked away from these crashes. Their cars had air bags.

The people in these crashes were in cars equipped with an air bag passive restraint system. Inflatable bags that automatically cushion driver and passenger in a frontal-type collision. Inflating, protecting, deflating in less than one-half second.

But the people in these crashes were lucky. Extraordinarily lucky.

Because there are only 1,800 air bag equipped cars on the road today. Used—in a program of on-road testing of air bag reliability—by the U.S. Government, Allstate and several other major companies.

The air bag's record in this program has been most impressive. It has *never* failed, in a real-life crash, to work to protect the occupants as it was designed to do.

In over 35 million miles of on-road testing has the air bag system *ever* inadvertently deployed? Yes. *Once.*

Once, in over 35 million miles of driving, one inadvertent inflation of the air bag has occurred. (The result? A minor hand injury to the right front passenger. However, the driver was completely unaffected and stopped the car without incident.)

But despite its impressive record of performance—including a mounting number of air bag successes like the ones shown here—the protection of air bags is still not available to the public.

We hope this situation is about to change.

Several years ago a Federal regulation was adopted that would have required *some kind of* passive restraint system in all 1974 model cars. But that deadline was called off. Now 1976 is the target year. So the debate continues over what kind of passive restraint system should be used in cars sold to the public. (A debate that's failed to produce any system as effective as air bags.)

We believe after *years* of air bag laboratory tests and over *35 million miles* of successful on-road testing, the time for debate is over.

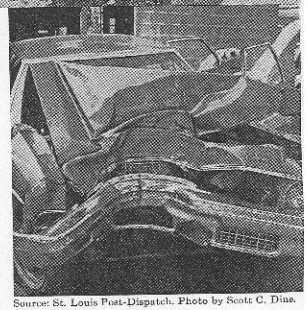
Today air bags are technologically ready to be installed in production-line cars. One car manufacturer, General Motors, has announced plans to offer air bags as an option on some 50,000 1974 cars—Cadillacs, Buicks and Oldsmobiles. We hope other companies will follow their example.

There's little doubt that some of the people in the crashes shown here would have been badly injured or killed if they'd been driving cars without air bags. A look at these photographs makes that clear.

Each year thousands of people are killed in automobiles. Well over a million more are seriously injured, many maimed for life. How many lives might be saved, how many injuries prevented, if air bags were available to every new car buyer?

The air bag is ready for America now. And America, Allstate believes, is ready for the air bag.

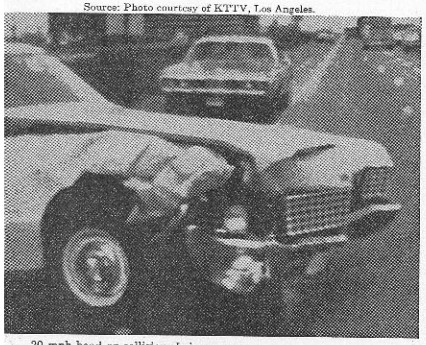
68 mph into a parked car. Injury: broken wrist and knee cap.
Lap belt: not in use.



Source: St. Louis Post-Dispatch. Photo by Scott C. Dine.

35 mph into utility pole. Injury to driver: slight nose fracture. Injury to passenger: sore shoulder.
Lap belts: not present.

Source: Photo courtesy of KTTV, Los Angeles.



20 mph head-on collision. Injury: none.
Lap belt: in use.

For details on the air bag and its record of performance, write to Director of Automotive Engineering, Allstate Insurance Company, Northbrook, Illinois 60062.

Allstate

When will yours?

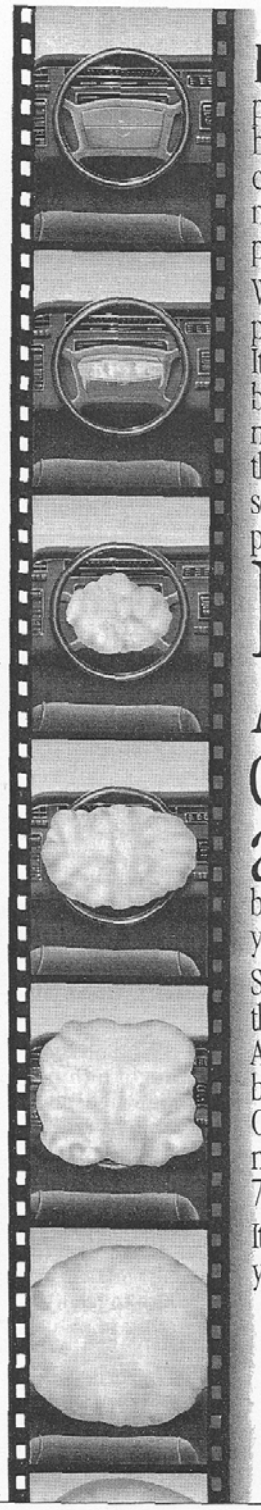
Figure 4-3 Allstate Airbag Advertisement (1990)

It's been proven time and time again. If you have a collision in a car that has an air bag, and you're wearing your seatbelt, your chances of being killed or seriously injured in a crash decrease by 55%.

In experience with our own fleet logging over 30 million miles and more than 300 crashes, in every one that was serious enough to deploy air bags, the drivers walked away without serious injury.

Getting air bags can keep the price of insurance from inflating.

In fact, if air bags were installed in all cars, claims for death and injury would be so reduced that consumers would save billions of dollars in insurance costs every year. And that's not even taking into account the positive effect air bags would have on life and health insurance costs.



In 1974, we became the first company to offer a discount for air bags. Right now, our policyholders can save up to 30% on their medical payment coverage or personal injury protection.

We were also one of the first companies to pioneer air bag research. It's proven the air bag's value to both the government and the automakers, and strengthened our belief that the combination of air bags and seatbelts provides the best occupant protection package available.

Here's what Allstate is doing about it.

We at Allstate believe in air bags so much, we'd like to encourage you to buy a car with them.

So we've put together a list of all the cars they're available in. See an Allstate agent to get your free copy before you shop for your next car. Or write, Allstate Consumer Information Center, Dept. 410, P.O. Box 7660, Mt. Prospect, IL 60056-9961.

It's information that could help you make a lifesaving decision.

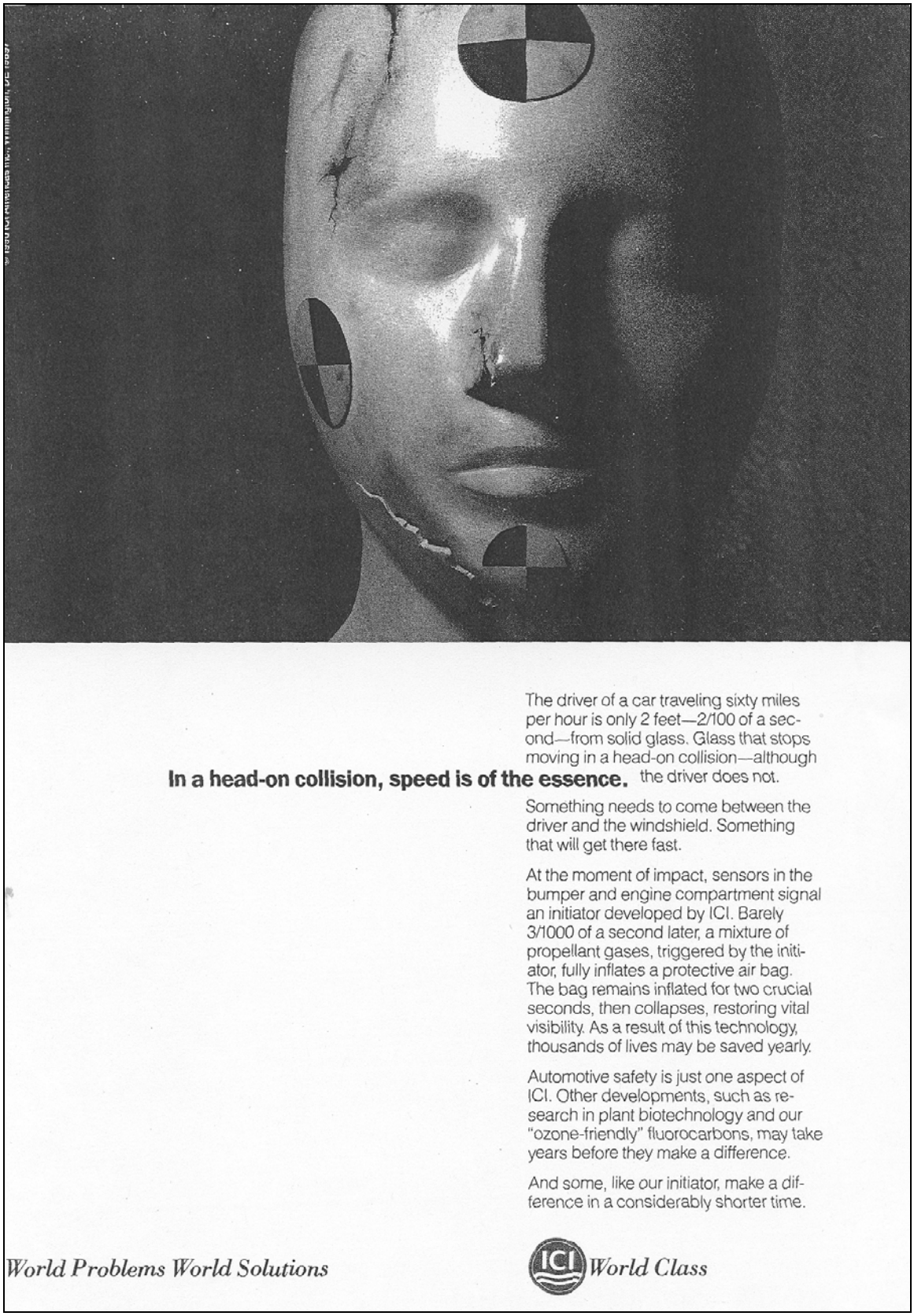
A member of the Sears Financial Network

Allstate

You're in good hands.

Discount not available in some states. © 1990 Allstate Insurance Company, Northbrook, Illinois.

Figure 4-4 Automotive Supplier Airbag Advertisement (1991)



4.2.2 Automakers & Auto Dealers

Automakers have a plethora of marketing techniques to overcome consumer resistance to a new vehicle, reduce excess inventory, and maintain market share. For example, in 1995 when Ford offered the remodeled Taurus, the flagship vehicle for the company, a large rise in price accompanied the styling changes. Consumers rejected the higher price, which forced Ford to discount the new model with rebates and lease deals. Despite a sticker price of $19,150 for the base model, the average transaction price quickly fell to roughly $18,000.[89]

Incentives and rebates, spearheaded by domestic automakers, have become the most visible form of consumer incentives in recent years. This trend developed during the late 1970s through the 1980s when expenditures for promotional programs grew much faster than expenditures for advertising.[90] While advertising is effective in producing long-term brand loyalty, promotions are primarily limited to increasing short-term sales. Such promotional strategies have been the subject of great debate due to possible negative effects. These adverse effects include 'forward buying,' which has been characterized as stealing sales from the future by encouraging a car shopper to purchase more quickly in order to receive the deal. The resale value of used cars that have had significant monetary incentives have been shown to fall faster than cars with no such incentive. An analysis by Edmunds.com found that about 85 percent of the value of all new-car incentives washes through to the used car prices of the same vehicle (i.e. $3,000 incentive = $2,550 instant depreciation on used car).[91] Larger and more widespread incentives may also lead to a consumer perception of product inferiority.

It was reported in October 2002 that GM incentive spending was $3,855 per vehicle in the third quarter of that year, which is not an unusually high figure.[92] A Vice President of GM, Bill Lovejoy, responded by saying, "incentives will stay in place until demand is more aligned to capacity." The capacity utilization trend has been steadily pointing downward for domestic automakers, which would seem to imply that rebates will remain an integral part of the car selling business for some time to come. GM also raised rebates on midsize vehicles in 2002 due to a lag in sales.[93] Carmakers offer incentives to stimulate sales, but the firms often couple rebates on less popular models with price increases on high-selling vehicles.[94] Incentives help move specific models that do not sell up to expectations for a variety of reasons, one of which may be added cost due to regulation. The bundling of options for cut rates or the offering of free options is another common form of incentive. As mentioned in the cost section of this report, Ford and GM bundled driver airbags with other options such as air-conditioning and anti-lock brakes for an effective price much lower than what the airbag option cost alone.

5 CONCLUSIONS AND LESSONS LEARNED

An important role of government is to assure that public goods and the public interest are protected. In the 1960s, policymakers determined that vehicle safety fell into this category and determined that government needed to play a stronger role in protecting vehicle occupants. One outcome of this process was the adoption of a passive restraint requirement (FMVSS 208). Adoption of the rule was contentious, created large uncertainty for industry, and suffered long implementation delays. In retrospect, the process could have been more efficient. While we have not made a definitive analysis of the cost-effectiveness of the process or outcome, we note that other approaches could have been pursued. These information and education campaigns such as was done with anti-smoking,[95] mandatory seatbelt laws such as those successfully adopted in Australia, New Zealand, Canada, Sweden, and Germany,[96] prescriptive "technological fix" standards for airbags such as was done with ignition interlock systems, and economic incentives built into insurance premiums or other existing tax mechanisms.

All these approaches have advantages and disadvantages. Some would be less expensive, take less time to implement and even perhaps improve safety faster and more effectively. And some could be pursued concurrently. Indeed various approaches were pursued at various times, including public education, ignition interlock requirements, and automatic seatbelts. But policy and rule adoption is not a straightforward process. Many interests are at stake, and consumer and industry concerns are varied. Consumers resent and generally oppose mandated behavioral requirements. They want invisible technology fixes, but of course question the price increases that go along with those fixes. Automotive companies fear losing a competitive edge to other companies, and resist rules that add cost and reduce overall vehicle sales.

In the end, after gaining the public's confidence, airbags were widely embraced – even though the cost was not trivial. Indeed, from 1972 to 1991 changes in safety regulations increased the cost of manufacturing a new automobile by $900, while emissions regulations accounted for a $1400 added cost.[97] The analysis conducted by Dunham concluded that changes in emissions control and safety regulations have had similar cost impacts, but that consumers value safety more. He cited evidence that the introduction of new safety devices depressed the price of used cars, implying the high value of safety equipment. . He found no such price-depressing effect for emissions control equipment. The eventual acceptance of airbags was due to the combination of perceived value, virtual invisibility of airbags to vehicle users, and a perception that the requirements did not unduly favor any particular set of companies (such as non-US companies).

While the adversarial relationship between automakers and policymakers slowed the regulatory process, the relationship became more conciliatory over time – in large part due to customer embrace of safety.

5.1.1 Lessons Learned

Government regulation of the automobile industry has been a contentious and extremely important policymaking arena for the last 35 years. The primary objective of these regulations has been to maximize social and environmental benefits and minimize the negative economic impact on the automakers. The regulations need to be equitable

across all of the different automakers, so as not to provide a competitive advantage for one over another. These regulations have had an enormous positive impact, while being implemented in such a way to keep the auto industry profitable and economically viable.

Below we identify some key lessons learned from the airbag experience that might be relevant to forthcoming greenhouse gas emission policy.

1. Automakers need to pass the cost of regulations on to consumers, and have a number of strategies to do so in ways that preserve profitability and sales volume. The more flexibility in the regulations, the more options available to automakers. In the case of passive restraints, the regulation at first attempted to specify acceptable alternatives to the airbag, namely automatic seatbelts, but this most likely did more harm than good since airbags proved to be the superior option. In the case of GHG regulation, automakers have a vast array of technological options available to lower GHG emissions. The airbag experience suggests that the broadest performance-based rules, with some flexibility in the phase-in schedule, are most desirable.

2. The cost of complying with passive restraint regulations, while overall quite significant, was typically small compared with the year-to-year variability in vehicle prices. Appendix A highlights price and sales changes for a number of vehicle models from a number of different manufacturers. The figures in the Appendix show a great deal of fluctuation from model year to model year without clear links to compliance costs or non-regulated improvements to the vehicle.

3. Inconsistent policy and a willingness to compromise led to ineffectual rulemaking and long delays in the case of airbags. While rulemaking flexibility is desirable, consistency and clear direction leads to a more efficient process. Between 1970 and 1984 the discussion of a passive restraint standard was in full swing, but an actual regulation was never passed and the benefits of such a regulation were forfeited. Even between 1984 and 1991, the regulation was not as direct as could be, which resulted in a lower benefit-cost ratio than could have been achieved. With GHG regulation, the regulation should convey the purpose and necessity in the process from start to finish.

4. Despite the strong opposition toward airbags based on cost and other considerations from automakers, it can be argued that the airbag standard has had a positive effect on the auto industry. The addition of airbags corresponded with higher consumer valuations of safety in general, and has led to a new growth industry that consumers value, and that saves lives and prevent injuries: a win-win solution. There is evidence that consumers have consistently valued the environment to a greater extent over time. By matching the regulation to a growing concern of consumers, regulators and automakers can create a smoother transition for the new technology that benefits all parties involved. In other words, if the public stand firmly behind the regulation, the job of implementing a standard will be greatly facilitated.

5. Truly independent government and private research reports are vital to fully understanding the costs and benefits of a potential regulation, and the policy options available to attain policy objectives. In the case of airbags, there was a great deal of conflicting evidence with respect to cost of compliance, consumer sentiment, and safety benefits of airbag technology. Advocates on either side of the debate tended to overestimate or underestimate findings based on their particular advocacy stance. One example involves automakers grossly overestimating the cost of compliance, and concluding from the high costs that there would be disastrous macroeconomic impacts due to the regulation. Another example involves government and insurance industry officials estimating benefits of lives saved and injuries reduced too optimistically. An example of a helpful, impartial analysis involved respected economist William Nordhaus, who had in the past tended to favor less regulation. Nordhaus conducted an analysis and filed a report stating that the rescission of the passive restraint standard would have a negative economic impact. This report was respected on both sides and was difficult to repudiate. With GHG regulation, both sides (government and environmental groups on one side and automakers and pro-business interests) should strive toward following impartial, scientific findings over stubborn ideological stances.

6. Advertising and marketing efforts by automakers themselves as well as other groups such as auto insurers assisted greatly in the transition to an airbag-equipped vehicle fleet. Consumers are skeptical of new technologies they do not understand, and while recognizing a problem such as deaths and injuries from automobile accidents or global warming, may not link these problems to their behavior or to potential solutions. Automakers like Mercedes-Benz and Chrysler showed through their advertising how an airbag worked and how it could save your life. For automakers, it is a difficult position because they are implicitly acknowledging that their products can lead to death and injury, or in the case of GHG regulation, contribute to global climate change. Automakers can receive beneficial 'halo effects' from promoting safety or environmental stewardship, and such business benefits will only increase as awareness of environmental problems and their link to light-duty vehicle use is increased.

7. The added cost of regulation will typically lead to a higher average price per vehicle, but this itself may have little effect on vehicle sales. Compliance cost can be recouped through a number of different approaches as shown in the report. In the case of airbags, the least expensive, most price-sensitive cars tended to have disproportionately lower price increases. It was also discovered that price setting is a fluid and complex process, which reflects a number of corporate goals including, but certainly not limited to, cost recovery. For moderate cost increases (<5% of average vehicle cost) due to regulation, automakers have shown adeptness at meeting regulation and maintaining sales volume. There is no reason to believe a GHG emissions regulation would be any different.

8. The costs of new technologies added to meet a given regulation decline quickly as economies of scale and learning effects are achieved. In the case of airbags, the cost or airbags fell dramatically as large volume production began. Cost not only fell, but quality and performance of airbag systems grew rapidly through the 1990s, and continues to grow to this day. It is important to fully analyze the cost differences between lower production schedules and high volume. If a handful of technologies are employed across all vehicles to meet a future GHG regulation, the costs of the added equipment will fall quickly, which should allow sufficient profit margins to be maintained.

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ABBREVIATIONS

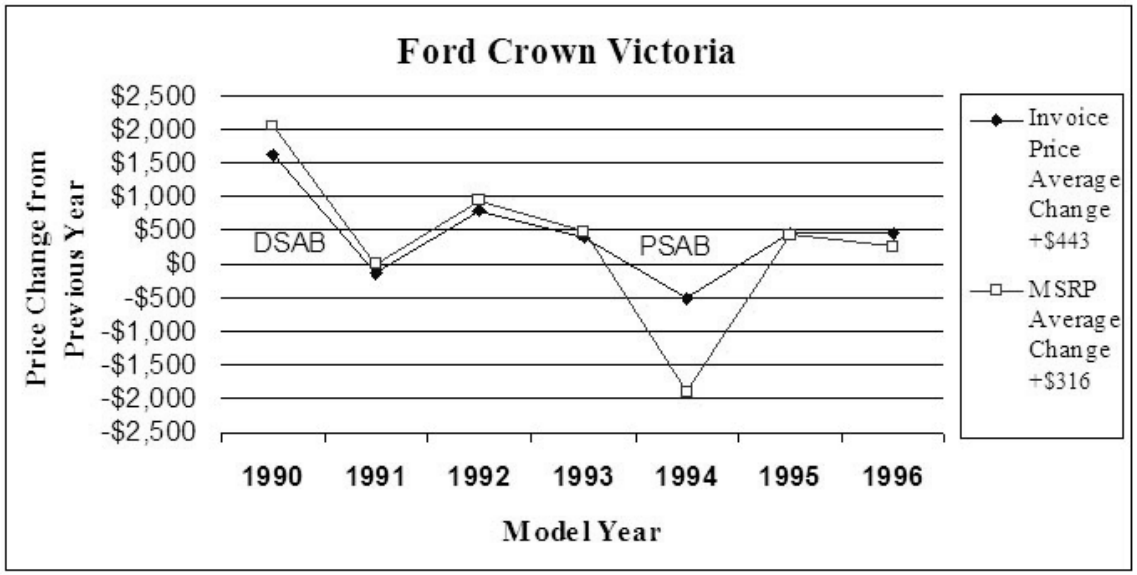
AAA – American Automobile Association
ABS – Anti-Lock Braking Systems
AOPA – Automobile Occupant Protection Association
CAS – Center for Auto Safety
DOT – Department of Transportation
EPA – Environmental Protection Agency
FHWA – Federal Highway Administration
FMVSS – Federal Motor Vehicle Safety Standards (e.g. FMVSS 208)
GAO – General Accounting Office
GHG – Greenhouse Gases
GM – General Motors
GSA – General Services Administration
IIHS – Insurance Institute for Highway Safety
ISTEA – Intermodal Surface Transportation Efficiency Act of 1991
NHSB – National Highway Safety Bureau
NHTSA – National Highway Traffic Safety Bureau
NMVSAC – National Motor Vehicle Safety Advisory Council
OEM – Original Equipment Manufacturer
RPE – Retail Price Equivalent
USAA – United Services Automobile Association

APPENDICES

APPENDIX A: CHANGES IN PRICE AND SALES VOLUME FOR 27 PASSENGER CARS

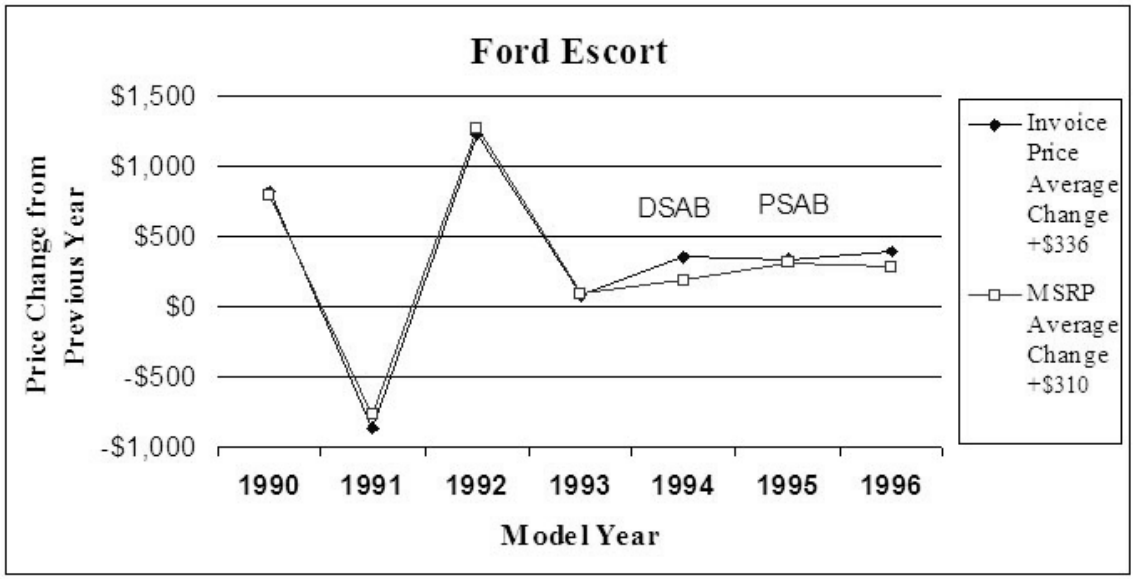
An important level of detail is lost when observing aggregate price changes. For example, the effect of when automakers lower prices on some cars while raising prices on others would merge into a mean thus nullifying the full effects. Incorporating a disaggregate approach into the analysis will help flesh out these important pricing subtleties. This Appendix contains a set of graphs that depict price change from the previous year of a number of representative car models over the1989 through 1996 model years when the integration of airbags into vehicles was at its highest rate. The prices are adjusted to constant 2002$ using the new vehicle consumer price index (CPI) furnished by the Bureau of Labor Statistics. The source used for the price and optional and standard equipment was the annual automotive issue of *Consumer's Digest*. The series in the particular model group was the base vehicle unless otherwise noted. The sales data for these models are also included, as well as the percentage of sales for a particular make attributable to that vehicle. The make is considered to be Chevrolet or Lincoln-Mercury, for example, and not General Motors or Ford Motor Co. *Ward's Automotive Yearbook* is the source for annual sales data.

Manufacturers often introduced airbags into vehicles with little styling change if any at all, which allows an analysis of this type to be fruitful. For example, when Chrysler introduced driver-side airbags into virtually the entire line of its domestically produced passenger cars for the 1990 model year, the cars underwent minimal styling modifications.[1] On the other hand, GM employed the opposite philosophy when it regularly introduced airbags jointly with styling changes. An analysis that looked at short-run profit maximization in the auto industry determined that domestic automakers raise prices significantly on models that undergo a major vehicle restyling, but no evidence indicated that Japanese manufacturers consistently exhibited this pricing behavior over the 1977-1992 period.[2]



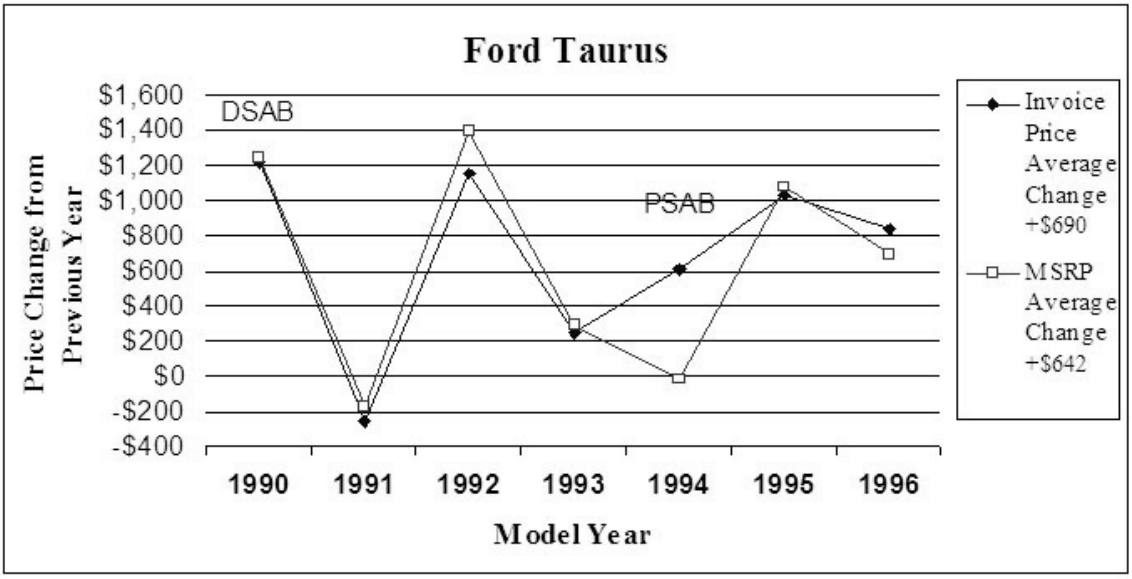
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		114,257	107,724	85,406	90,804	99,860	103,653	96,458	106,211
% of Make		7.2%	8.1%	7.7%	7.8%	7.7%	7.7%	7.2%	8.5%
Inv.	Current$	$13,663	$15,300	$15,724	$16,864	$17,654	$17,743	$18,601	$19,402
Inv.	2002$	$15,738	$17,361	$17,230	$18,033	$18,433	$17,913	$18,374	$18,839
MSRP	Current$	$15,581	$17,611	$18,227	$19,563	$20,493	$19,300	$20,160	$20,760
MSRP	2002$	$17,947	$19,983	$19,973	$20,919	$21,397	$19,484	$19,913	$20,158

For the 1990 model year Ford made standard a driver airbag, but raised the MSRP roughly $2000. The 1990 Crown Victoria also added power windows and mirrors, an auto parking braking release, and a tilt steering wheel as standard equipment, as well as a great many more optional equipment offerings including a number of preferred equipment packages. In 1991 no new standard equipment was offered, and in 1992 not much new was added, but the design was described as “all-new” and “modern.” For the 1994 model year a passenger airbag was made standard accompanied by a substantial price decrease. This was an unusual pricing practice because there was no observable decontenting, so clearly there was an ulterior driver at work besides passing on the added cost of the airbag to the consumer. The profit margin for the dealer shrunk considerably since the wholesale price fell only a quarter as much as the MSRP. During this timeframe, the sales volume as a percentage of Ford’s total sales remained consistent with the biggest jumps occurring with the addition of a driver airbag in 1990 and then again in 1996.



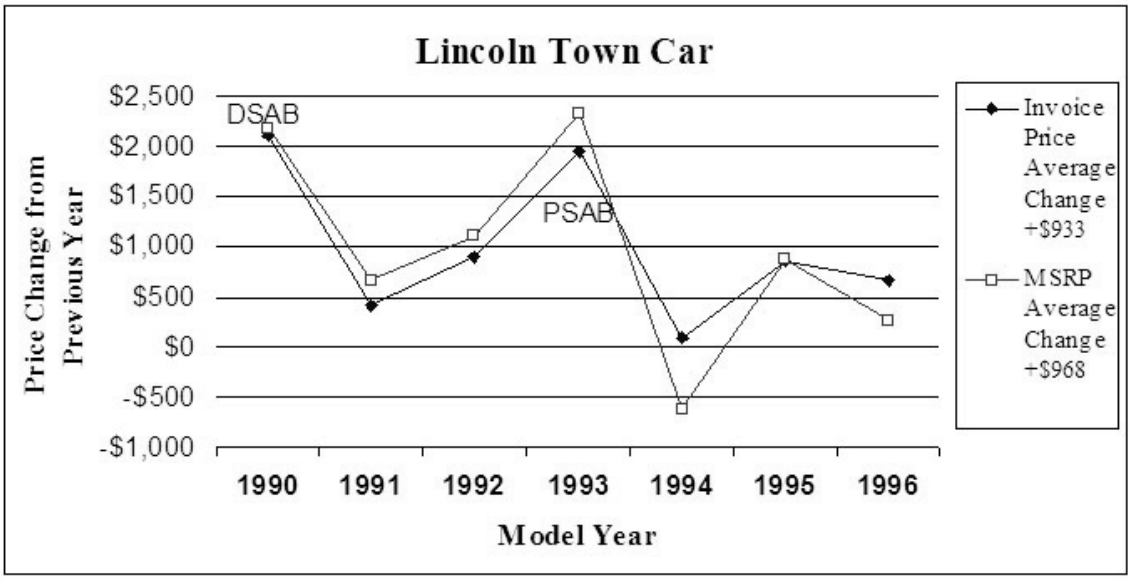
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		366,354	277,262	264,363	244,321	241,279	326,757	301,617	292,900
% of Make		23.1%	20.8%	23.7%	21.1%	18.6%	24.4%	22.6%	23.4%
Inv.	Current$	$6,915	$7,738	$7,230	$8,559	$8,839	$9,496	$10,042	$10,627
Inv.	2002$	$7,965	$8,780	$7,922	$9,152	$9,229	$9,587	$9,919	$10,319
MSRP	Current$	$7,679	$8,492	$8,095	$9,483	$9,797	$10,325	$10,870	$11,345
MSRP	2002$	$8,845	$9,636	$8,870	$10,140	$10,229	$10,424	$10,737	$11,016

The LX 4-door hatchback was used for the analysis, but a great deal of Δ price variance was observed among the different series of Escorts. There was little to no change in standard equipment on the subcompact car other than the inclusion of airbags during this timeframe. As a low-priced, economy car, Ford had very little room both in price and equipment with which to maneuver. Possibly due in part to the newly standard driver airbag, sales surged in 1994, although that year experienced an industry-wide peak in sales as well.



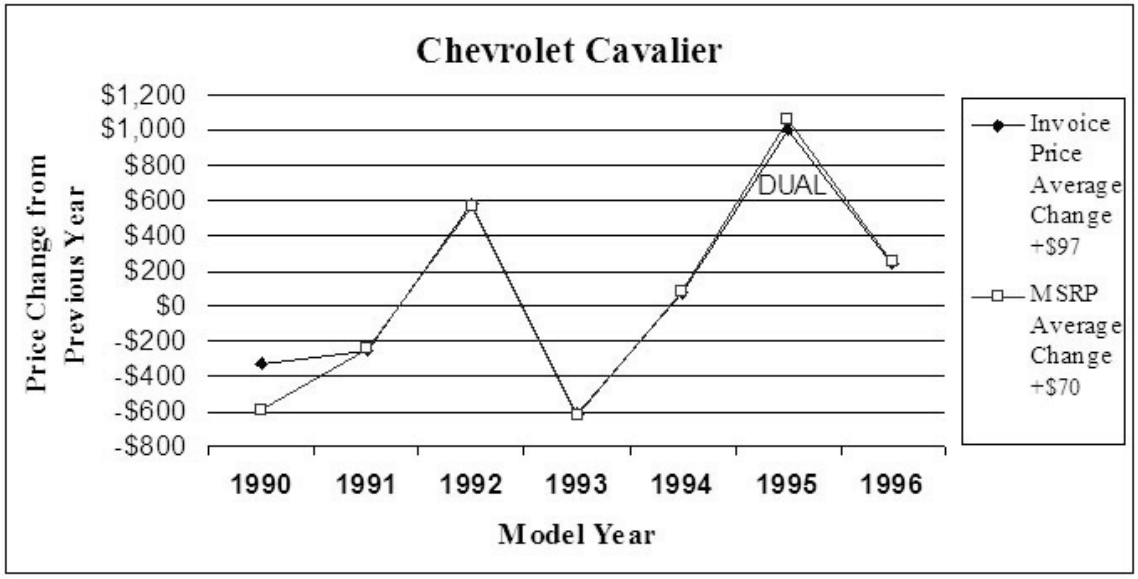
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		360,237	316,906	296,623	347,534	399,573	380,842	397,763	378,144
% of Make		22.8%	23.8%	26.6%	30.0%	30.8%	28.4%	29.8%	30.2%
Inv.	Current$	$10,152	$11,381	$11,548	$12,908	$13,455	$14,519	$15,887	$17,019
Inv.	2002$	$11,694	$12,914	$12,654	$13,803	$14,048	$14,658	$15,693	$16,526
MSRP	Current$	$11,778	$13,044	$13,352	$14,980	$15,623	$16,140	$17,585	$18,600
MSRP	2002$	$13,566	$14,801	$14,631	$16,018	$16,312	$16,294	$17,370	$18,061

The $1200 increase in price when the driver airbag was added for the 1990 model year is a clear example of the automaker passing on the cost of the airbag to the consumer. Power mirrors and tilt steering were also new equipment, but the much costlier airbag is most likely the source for much of the price spike. Ford made the power mirrors optional when the company introduced the 1994 Taurus with dual airbags and a virtually unchanged sticker price. Again the profit margin for the dealer was squeezed. The following year the price jumped about $1000 due at least in part to air conditioning, a rear defroster and power mirrors all being made standard. Air conditioning alone had been priced in the neighborhood of $700 as an option.



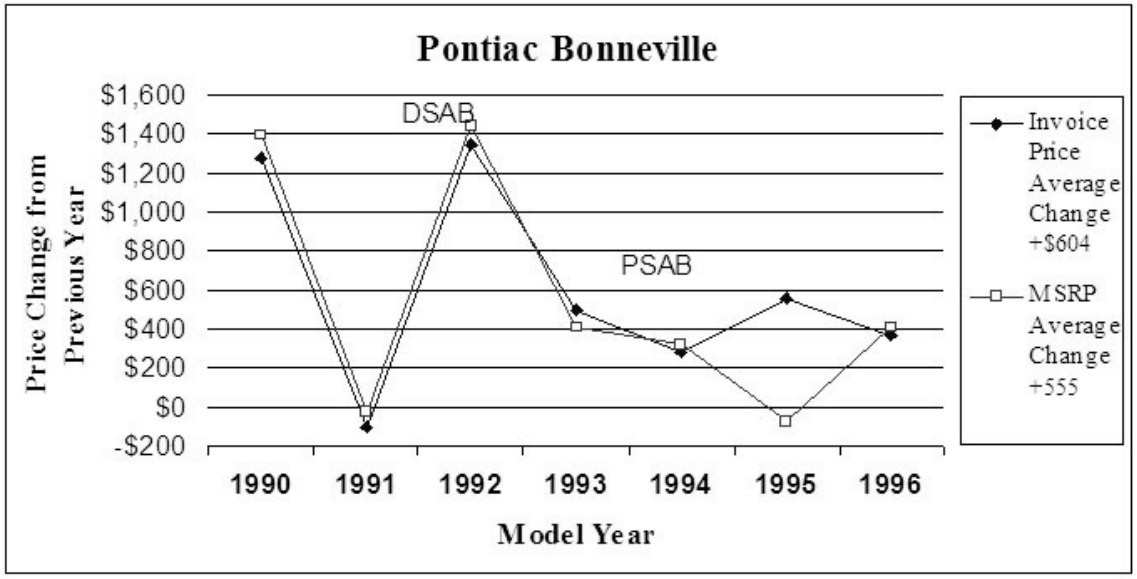
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		117,806	141,157	126,987	111,697	110,371	118,300	103,045	92,426
% of Make		16.9%	23.0%	22.4%	20.1%	18.9%	20.9%	19.2%	18.4%
Inv.	Current$	$21,721	$23,893	$25,128	$26,577	$29,080	$30,166	$31,699	$32,928
Inv.	2002$	$25,019	$27,112	$27,535	$28,419	$30,363	$30,454	$31,311	$31,973
MSRP	Current$	$25,562	$27,865	$29,458	$31,211	$34,190	$34,750	$36,400	$37,300
MSRP	2002$	$29,443	$31,619	$32,279	$33,374	$35,698	$35,082	$35,955	$36,218

The Lincoln Town Car is one of the highest-end production cars built by Ford Motor Co. Judging from the large price spikes of $2000 or more each when driver and then passenger airbags were introduced, the company could be recouping much of its airbag development and production costs through the greater profits generated from their luxury cars. ABS ($787 option) were also made standard along with the passenger airbag ($415 option) on 1993 models.



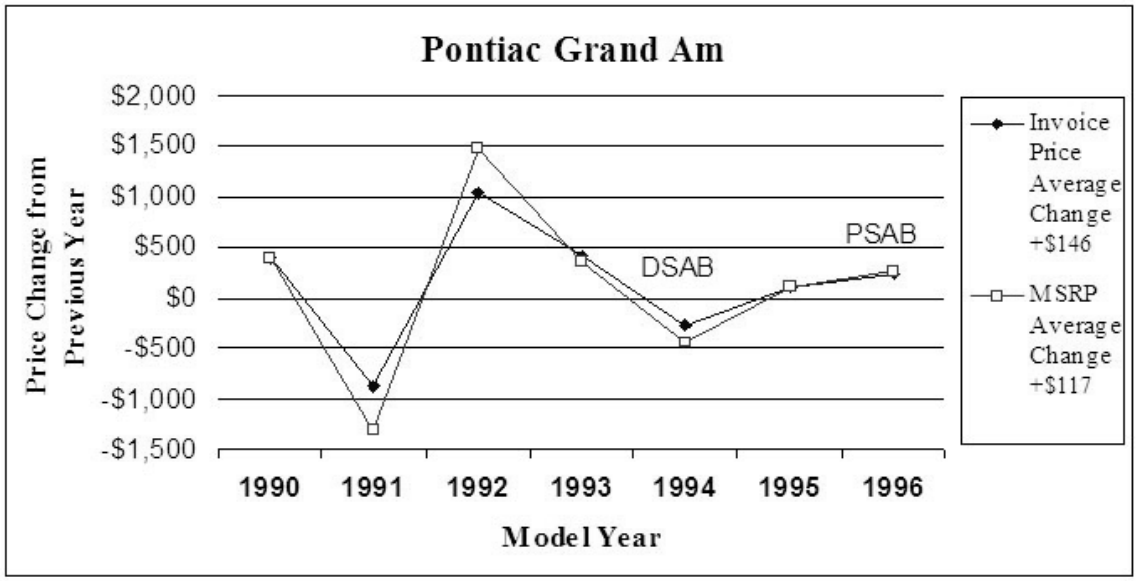
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		306,518	288,029	281,378	212,675	249,388	247,029	162,984	277,352
% of Make		21.8%	21.3%	23.7%	20.5%	24.8%	24.0%	16.0%	24.8%
Inv.	Current$	$7,934	$7,759	$7,799	$8,531	$8,146	$8,501	$9,701	$10,112
Inv.	2002$	$9,139	$8,804	$8,546	$9,122	$8,505	$8,582	$9,582	$9,819
MSRP	Current$	$8,595	$8,202	$8,270	$8,999	$8,620	$8,995	$10,265	$10,700
MSRP	2002$	$9,900	$9,307	$9,062	$9,623	$9,000	$9,081	$10,139	$10,390

The Cavalier is another example of the firm passing on the cost of airbags to consumers. A sensitive price elasticity can also be inferred qualitatively from the data. The 1992 model year saw an increase in price of $600 and a resultant drop in sales of nearly 70,000 cars. The following year GM reversed the price change and lowered the MSRP $600 and sales bounced back. When dual airbags were finally installed in 1995 and the cost looked to be passed on to the tune of $1000, the percentage of Chevrolet sales attributable to Cavalier fell from nearly a quarter to under a sixth. The extreme price sensitivity of the Cavalier is the reason the average annual price hike is under $100.



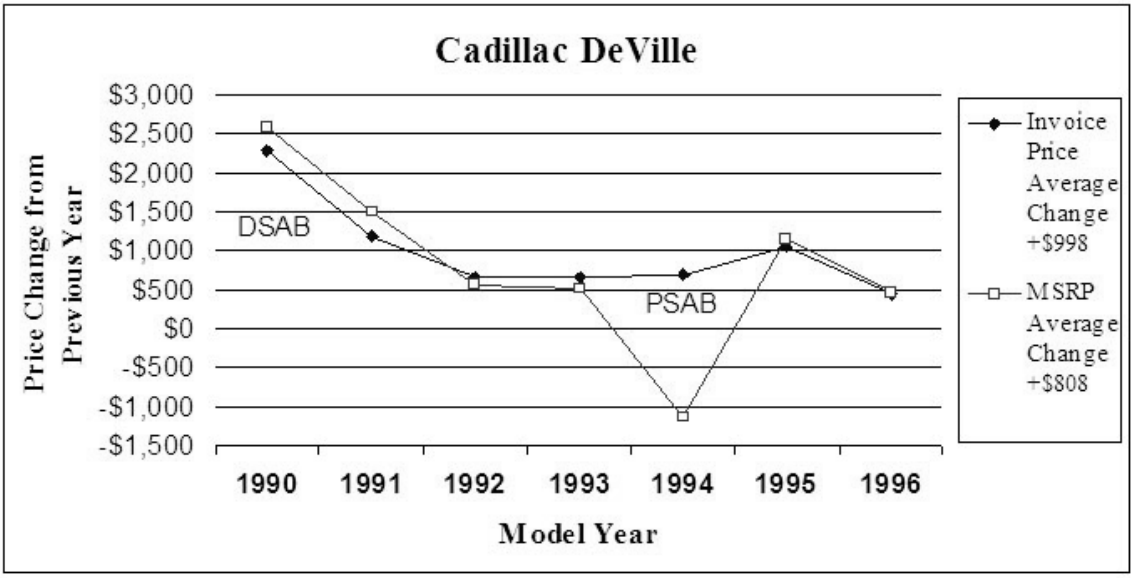
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		94,761	69,322	64,349	98,595	91,643	92,672	82,954	78,554
% of Make		12.9%	10.9%	12.5%	19.0%	17.6%	15.4%	15.0%	14.6%
Inv.	Current$	$12,798	$14,118	$14,527	$16,144	$17,014	$17,871	$18,828	$19,539
Inv.	2002$	$14,741	$16,020	$15,918	$17,263	$17,764	$18,042	$18,598	$18,972
MSRP	Current$	$14,829	$16,279	$16,834	$18,599	$19,444	$20,424	$20,804	$21,589
MSRP	2002$	$17,081	$18,472	$18,446	$19,888	$20,302	$20,619	$20,550	$20,963

Unlike the Cavalier, sales of the Bonneville do not exhibit price sensitivity. The best sales year in this timeframe was 1992 when a driver airbag was made standard, and the price of the optional ABS fell from$787 to $383. In the following two model years, GM made standard first ABS, and then passenger airbags with a below average increase in vehicle price.



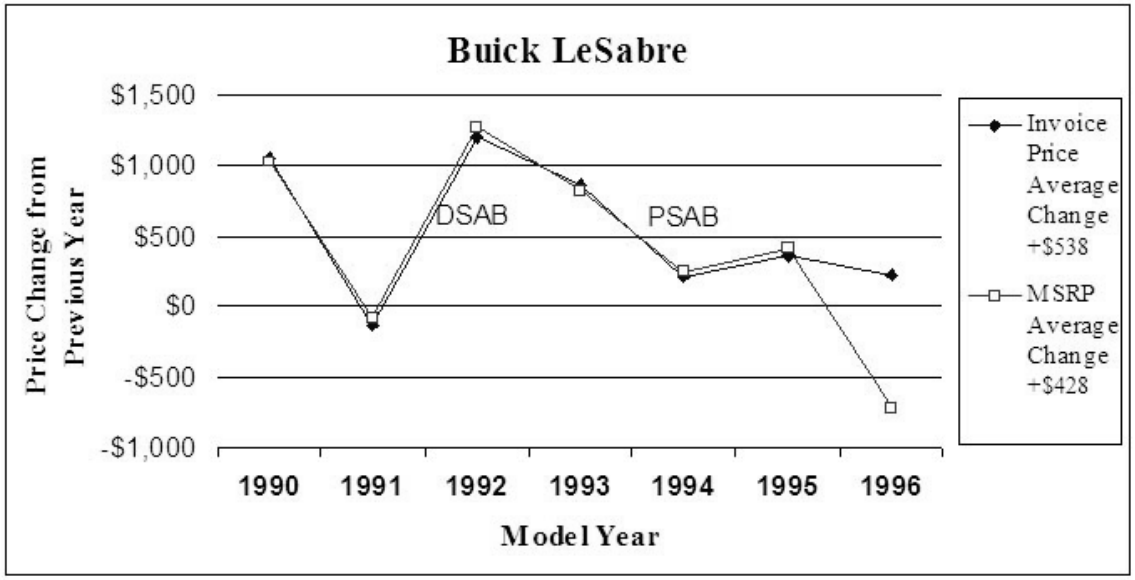
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		217,169	208,813	151,320	198,596	211,544	243,682	246,778	224,530
% of Make		29.6%	32.9%	29.4%	38.3%	40.6%	40.5%	44.7%	41.6%
Inv.	Current$	$9,528	$10,019	$9,576	$10,775	$11,425	$11,542	$11,899	$12,352
Inv.	2002$	$10,975	$11,369	$10,493	$11,522	$11,929	$11,652	$11,753	$11,994
MSRP	Current$	$10,669	$11,169	$10,374	$11,999	$12,624	$12,614	$13,004	$13,499
MSRP	2002$	$12,289	$12,674	$11,368	$12,831	$13,181	$12,735	$12,845	$13,108

The Grand Am is an affordable compact car like the Cavalier, but is somewhat sportier, and its sales and pricing behavior are markedly different. The Grand Am also received airbags relatively late, and with an average price hike of about $0 between the two model years when airbags were introduced, it is clear that GM wasn't passing the cost on directly, at least in the short run. When ABS and fog lights were made standard on 1992 models, the price increase was significant, but the sales did not suffer. Sales were at the highest in 1994 and 1995 when a car buyer could get standard ABS and an airbag in a sporty package for under $13,000.



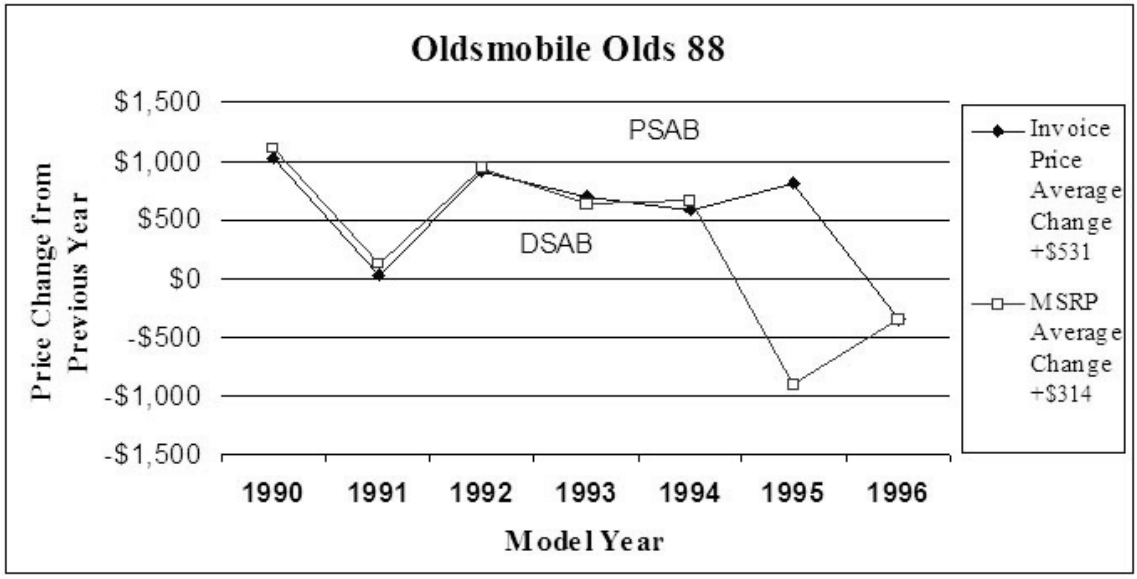
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		177,907	163,542	147,251	136,238	122,173	115,935	110,830	108,349
% of Make		64.6%	63.7%	67.4%	63.8%	57.8%	55.4%	60.5%	61.5%
Inv.	Current$	$21,697	$24,042	$25,979	$27,233	$28,537	$30,186	$31,934	$32,936
Inv.	2002$	$24,992	$27,281	$28,467	$29,121	$29,796	$30,475	$31,543	$31,981
MSRP	Current$	$25,435	$28,090	$30,455	$31,740	$32,990	$32,990	$34,900	$35,995
MSRP	2002$	$29,297	$31,874	$33,372	$33,940	$34,445	$33,305	$34,473	$34,951

Sales of the DeVille declined consistently during this timeframe, probably due more to cultural currents and consumer tastes, than anything quantifiable. For instance, many consumers who would have considered a DeVille were now in the market for an SUV. The 1990 model year was the first time GM offered standard airbag and ABS, and if the price increase of the DeVille is any indication, the company was trying to recoup its investment in a hurry. The price stabilized for the rest of the period perhaps in response to the slumping sales.



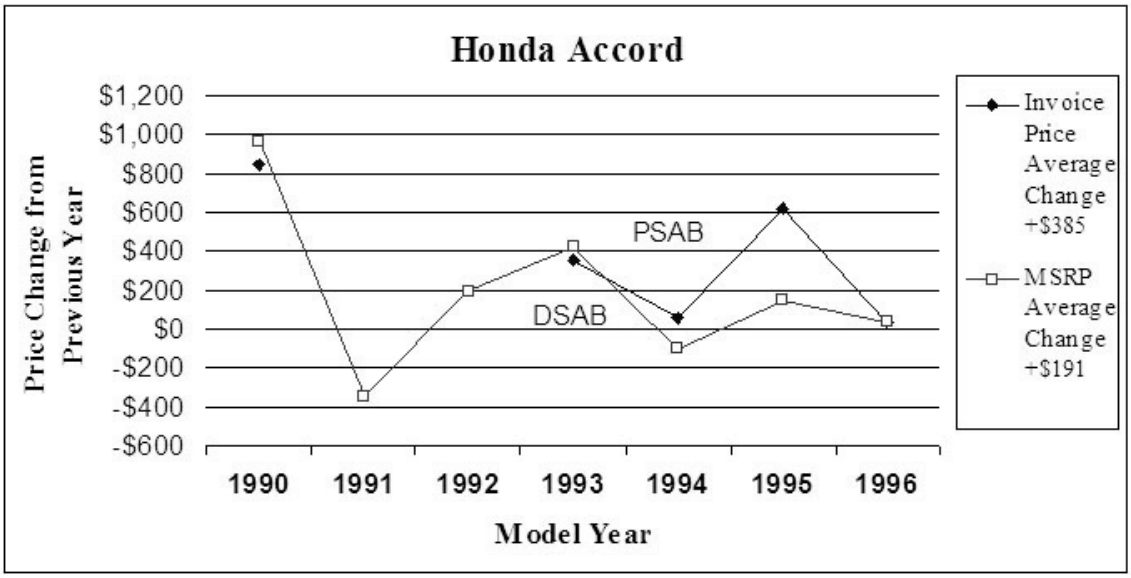
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		148,407	152,036	102,029	145,290	150,964	154,499	142,624	136,071
% of Make		25.9%	29.3%	18.7%	27.4%	30.0%	28.9%	29.2%	30.4%
Inv.	Current$	$13,229	$14,356	$14,741	$16,228	$17,444	$18,253	$19,019	$19,573
Inv.	2002$	$15,238	$16,290	$16,153	$17,353	$18,213	$18,427	$18,786	$19,005
MSRP	Current$	$15,425	$16,555	$17,080	$18,695	$19,935	$20,860	$21,735	$21,380
MSRP	2002$	$17,767	$18,785	$18,716	$19,991	$20,814	$21,059	$21,469	$20,760

LeSabre sales suffered in 1991, arguably because many of the domestic cars in its class had a standard driver airbag. The following year GM added the airbag, ABS and over $1000, and sales promptly rebounded.



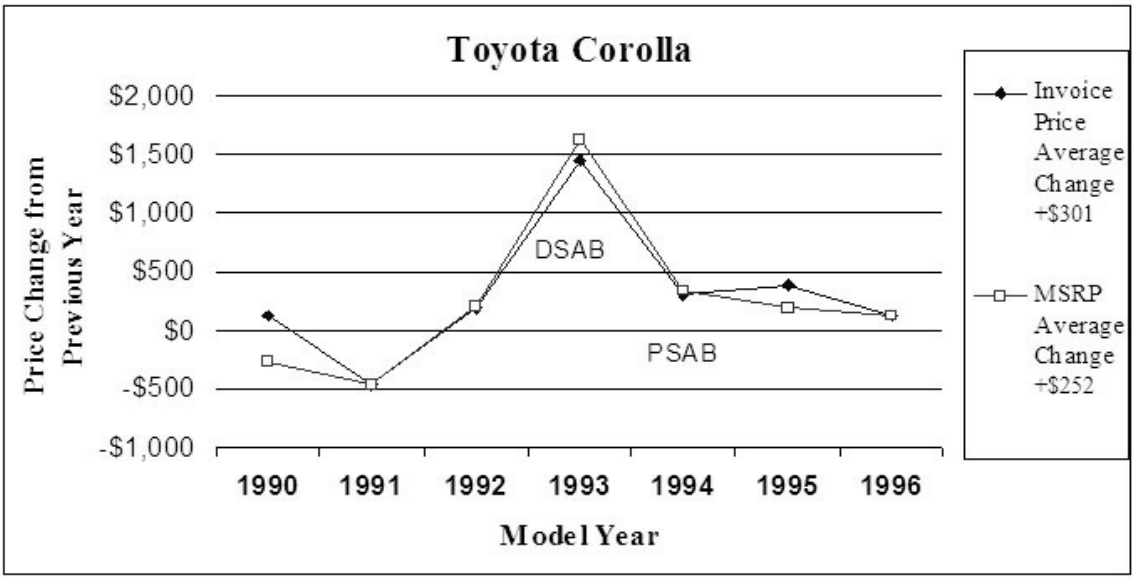
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		148,173	104,310	75,975	81,041	67,295	77,192	61,279	59,922
% of Make		22.7%	20.7%	17.0%	19.9%	18.7%	18.7%	15.7%	18.4%
Inv.	Current$	$13,200	$14,309	$14,840	$16,054	$17,106	$18,266	$19,492	$19,487
Inv.	2002$	$15,204	$16,237	$16,261	$17,167	$17,860	$18,441	$19,254	$18,922
MSRP	Current$	$15,295	$16,500	$17,195	$18,495	$19,549	$20,875	$20,410	$20,405
MSRP	2002$	$17,617	$18,723	$18,842	$19,777	$20,411	$21,075	$20,160	$19,813

The Oldsmobile Eighty-Eight was another GM product that fell dramatically in popularity during the period for reasons that are not well understood. GM offered a driver airbag for $723 up until the company included it as standard in 1993. Likewise, ABS were $787 before becoming standard in 1992. GM barely passed the cost of these devices onto the consumer probably due to the diminishing sales volume. GM would eventually terminate the Oldsmobile division in 2002.



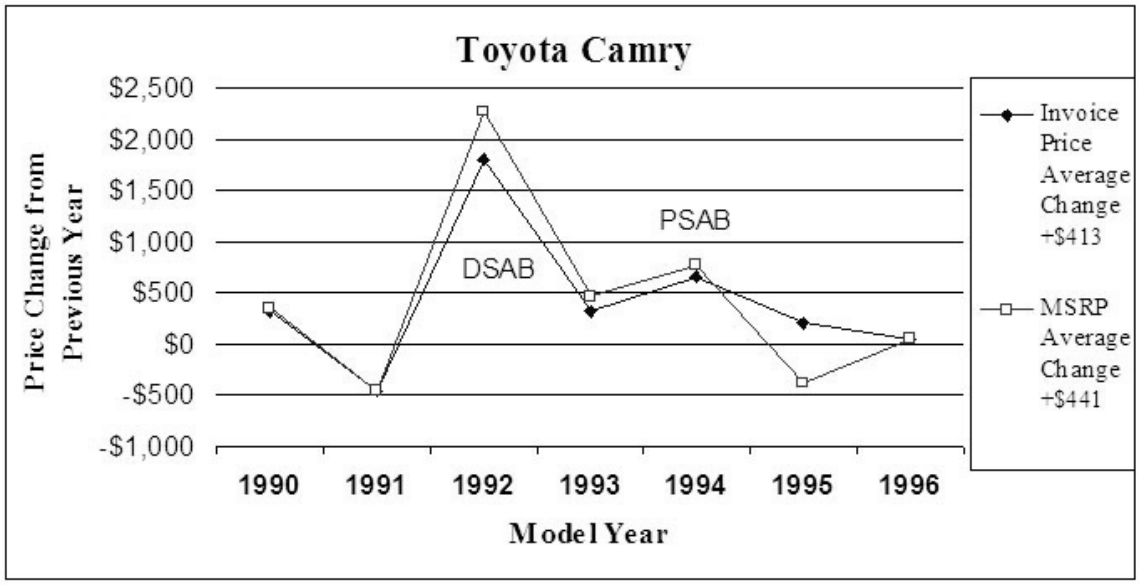
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		362,435	416,957	409,704	387,881	343,017	362,407	345,855	367,137
% of Make		55.4%	58.8%	60.5%	60.4%	55.2%	56.1%	53.5%	54.1%
Inv.	Current$	$9,719	$10,614	NA	$11,109	$11,718	$12,181	$13,078	$13,343
Inv.	2002$	$11,195	$12,044	NA	$11,879	$12,235	$12,297	$12,918	$12,956
MSRP	Current$	$11,570	$12,590	$12,725	$13,225	$13,950	$14,330	$14,800	$15,100
MSRP	2002$	$13,327	$14,286	$13,944	$14,142	$14,565	$14,467	$14,619	$14,662

The Accord, a perennial top-seller, received airbags in consecutive years with very little combined price upsurge. When Honda raised prices the most in this timeframe, inexplicably the company also sold the most Accords. Other than some styling changes, Honda did not fiddle much with its flagship car in the way of added equipment. The dealer price rose significantly in the year following the addition of the passenger airbag.



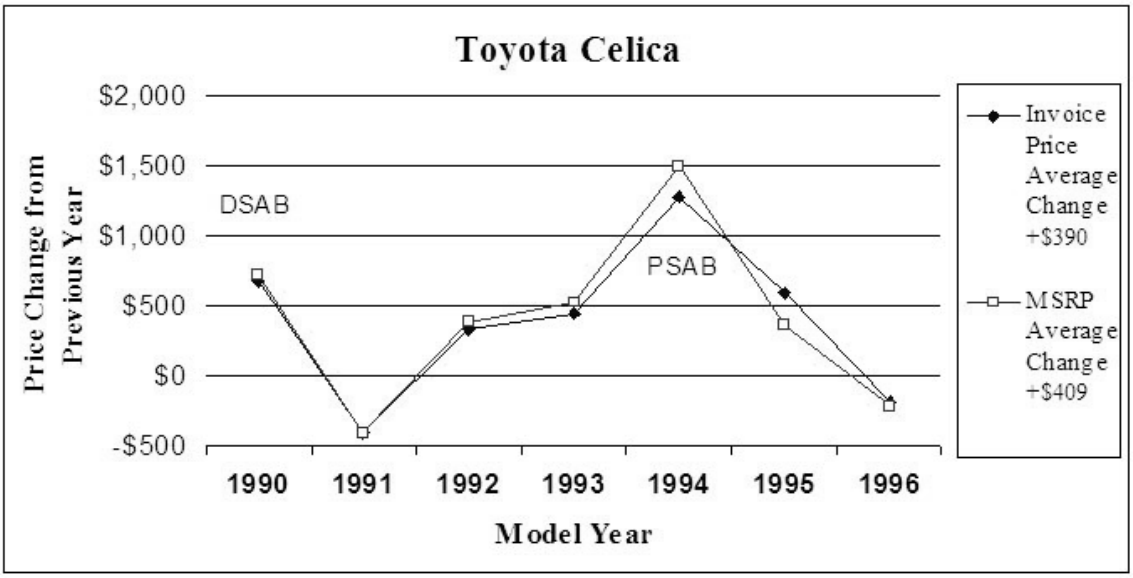
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		209,781	221,947	201,423	206,560	196,118	206,942	203,980	216,167
% of Make		30.3%	29.0%	27.1%	27.0%	25.7%	27.4%	26.3%	27.0%
Inv.	Current$	$7,909	$8,136	$8,008	$8,382	$9,966	$10,607	$11,236	$11,554
Inv.	2002$	$9,110	$9,232	$8,775	$8,963	$10,406	$10,708	$11,099	$11,219
MSRP	Current$	$9,198	$9,098	$8,998	$9,418	$11,198	$11,918	$12,378	$12,728
MSRP	2002$	$10,595	$10,324	$9,860	$10,071	$11,692	$12,032	$12,227	$12,359

An uncharacteristically large price hike and a styling overhaul accompanied the addition of an airbag in 1993. The relative price sensitivity of the Corolla can be spotted in the fall of sales during that year despite the styling and trim changes. The cost of the passenger airbag does not appear to have been passed onto the consumer during the first year or subsequent years.



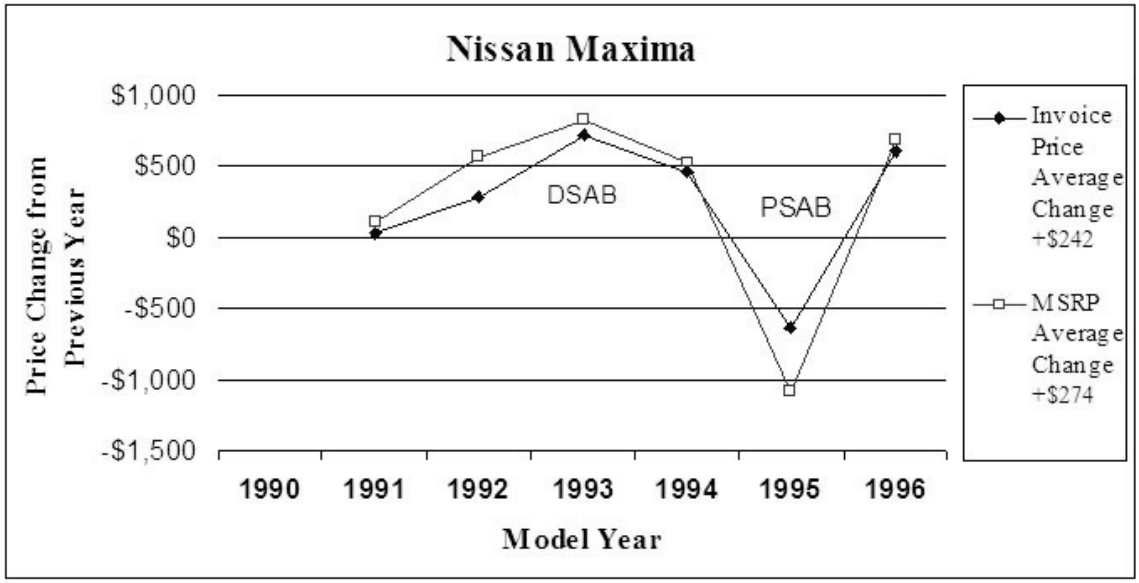
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		264,598	278,086	266,631	277,792	306,586	319,317	319,805	354,035
% of Make		38.2%	36.3%	35.9%	36.3%	40.1%	42.3%	41.2%	44.3%
Inv.	Current$	$9,880	$10,316	$10,275	$12,213	$12,809	$13,890	$14,401	$14,700
Inv.	2002$	$11,380	$11,706	$11,259	$13,060	$13,374	$14,023	$14,225	$14,274
MSRP	Current$	$11,448	$11,938	$11,948	$14,368	$15,158	$16,438	$16,418	$16,758
MSRP	2002$	$13,186	$13,546	$13,092	$15,364	$15,827	$16,595	$16,217	$16,272

The sales of Toyota's flagship car climbed steadily during this period. For the 1992 model year, the Camry underwent some changes including a driver airbag, more powerful engine, and some styling modifications. These changes were passed onto the consumer, but sales were not adversely affected by the steep rise in price. Part or all of the cost of the passenger airbag also appears to have been passed through during the year it was introduced.



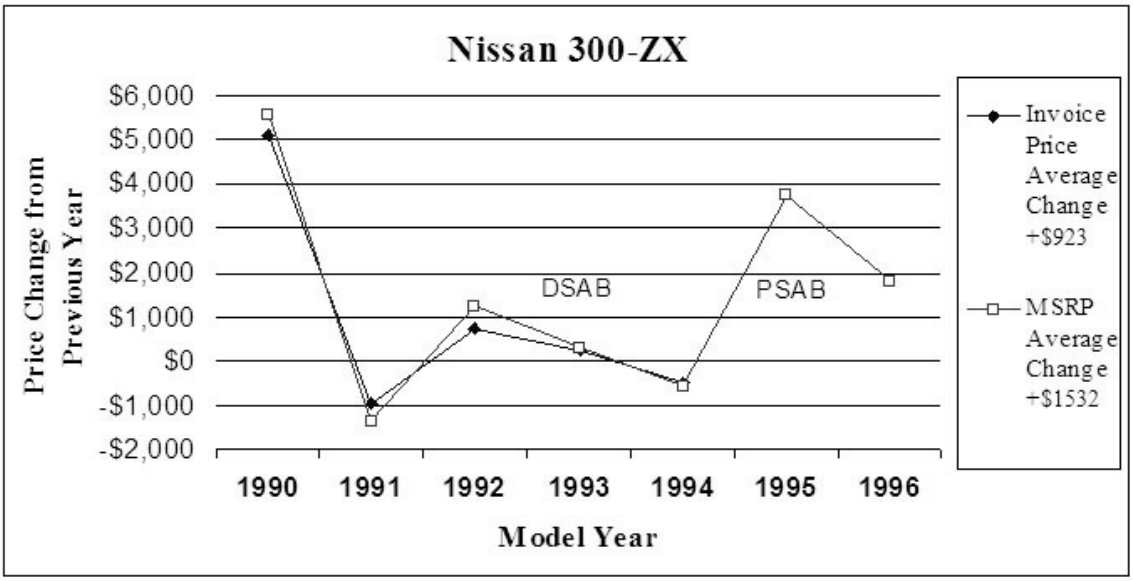
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		57,794	81,899	66,360	43,175	30,915	35,710	23,399	15,990
% of Make		8.3%	10.7%	8.9%	5.6%	4.0%	4.7%	3.0%	2.0%
Inv.	Current$	$10,096	$10,839	$10,857	$11,438	$12,139	$13,824	$14,727	$14,789
Inv.	2002$	$11,629	$12,299	$11,897	$12,231	$12,674	$13,956	$14,547	$14,360
MSRP	Current$	$11,808	$12,618	$12,698	$13,378	$14,198	$16,168	$16,888	$16,958
MSRP	2002$	$13,601	$14,318	$13,914	$14,305	$14,824	$16,323	$16,681	$16,466

In 1990, the Celica became the most affordable Japanese car with a standard airbag, the cost of which appears to have been passed on to the buyer. The sales rose dramatically as well signaling that the airbag and the higher price tag did not deter sales, and may have stimulated sales growth. When a passenger airbag was introduced for the 1994 model year, it was part of a redesigned and restyled sportier coupe evinced in the higher price tag.



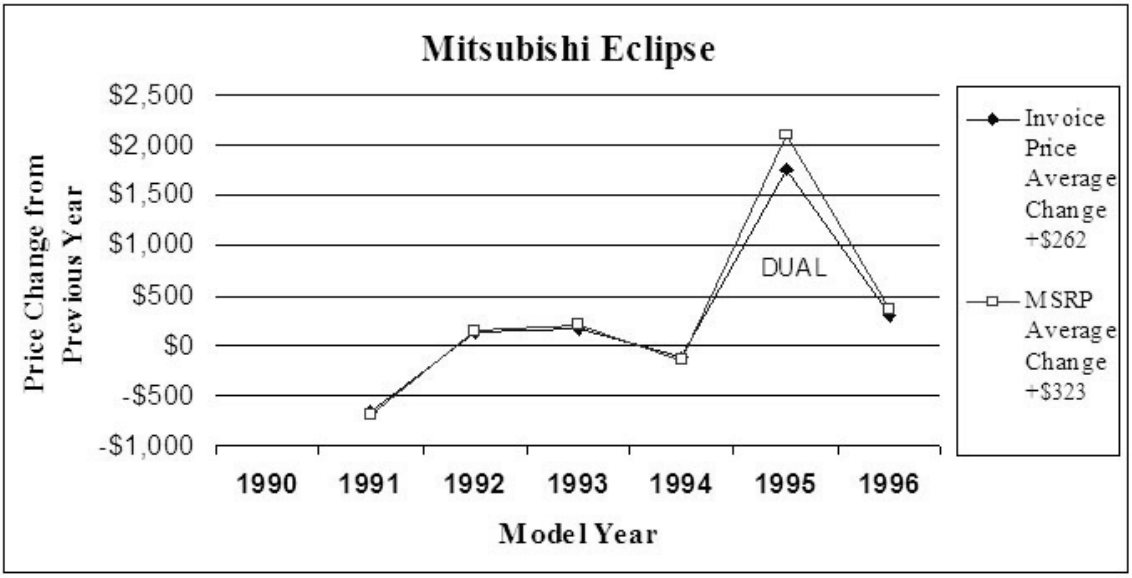
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		105,982	100,730	103,252	86,681	93,808	117,802	128,788	129,284
% of Make		20.8%	21.9%	24.4%	21.4%	19.8%	22.2%	24.1%	25.3%
Inv.	Current$	NA	$15,812	$16,403	$17,076	$18,172	$19,246	$19,021	$19,973
Inv.	2002$	NA	$17,942	$17,974	$18,260	$18,974	$19,430	$18,788	$19,394
MSRP	Current$	NA	$17,959	$18,699	$19,695	$20,960	$22,199	$21,599	$22,679
MSRP	2002$	NA	$20,378	$20,490	$21,060	$21,884	$22,411	$21,335	$22,021

A driver-side airbag was made standard on the Maxima in 1993 accompanied by a well above average price increase. The addition of the passenger-side airbag actually came with a significant price decrease. Some of the cost of the airbag system may have been absorbed, recouped the following year, or recovered by price increases in other models. For instance, in 1995 passenger airbags were also added to the Nissan 300 ZX along with a nearly $4,000 price increase. The price increase in 1996 for the 300 ZX was another $2,000.



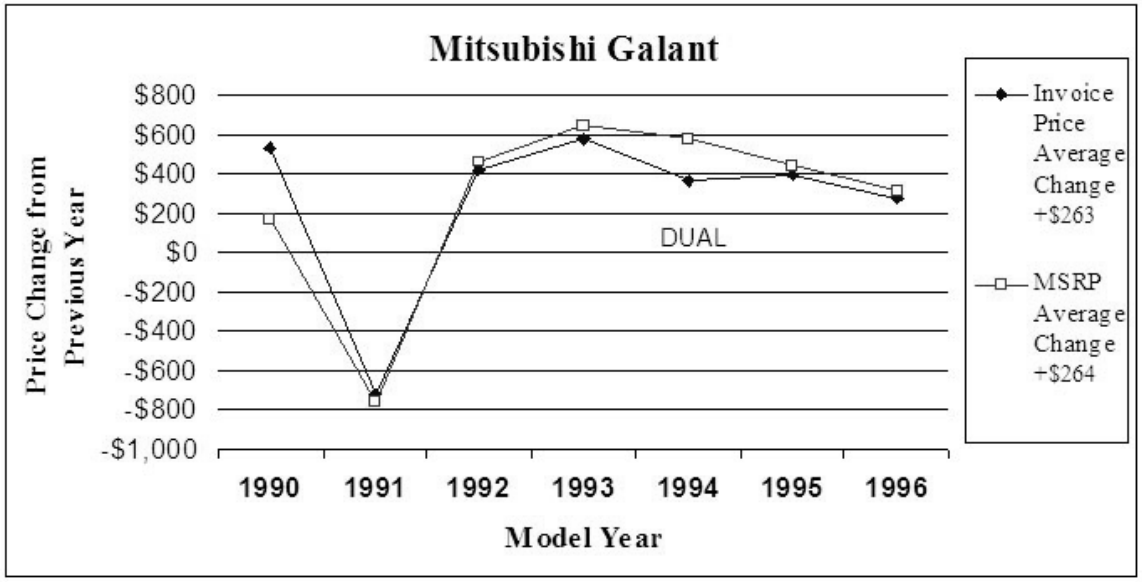
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		23,918	22,663	16,973	11,810	9,095	7,156	4,351	2,785
% of Make		4.7%	4.9%	4.0%	2.9%	1.9%	1.3%	0.8%	0.5%
Inv.	Current$	$18,940	$23,697	$23,669	$24,950	$25,786	$26,179	NA	$32,392
Inv.	2002$	$21,816	$26,889	$25,936	$26,679	$26,923	$26,429	NA	$31,453
MSRP	Current$	$22,299	$27,560	$27,300	$29,120	$30,095	$30,555	$35,009	$37,493
MSRP	2002$	$25,685	$31,273	$29,915	$31,138	$31,422	$30,847	$34,581	$36,406

The 300 ZX showed a great deal of price as well as sales volatility over this period. The average change in MSRP was $1,532, which included jumps of $5,500 and $4,000. The driver-side airbag was introduced with a very small price increase followed the next year by a price decline. When the passenger-side airbag became standard in 1995, the MSRP jumped by $4,000, but the sales continued to decline at the same steady pace. This 300 ZX was nearing the end of its lifecycle as the sales ebbed.



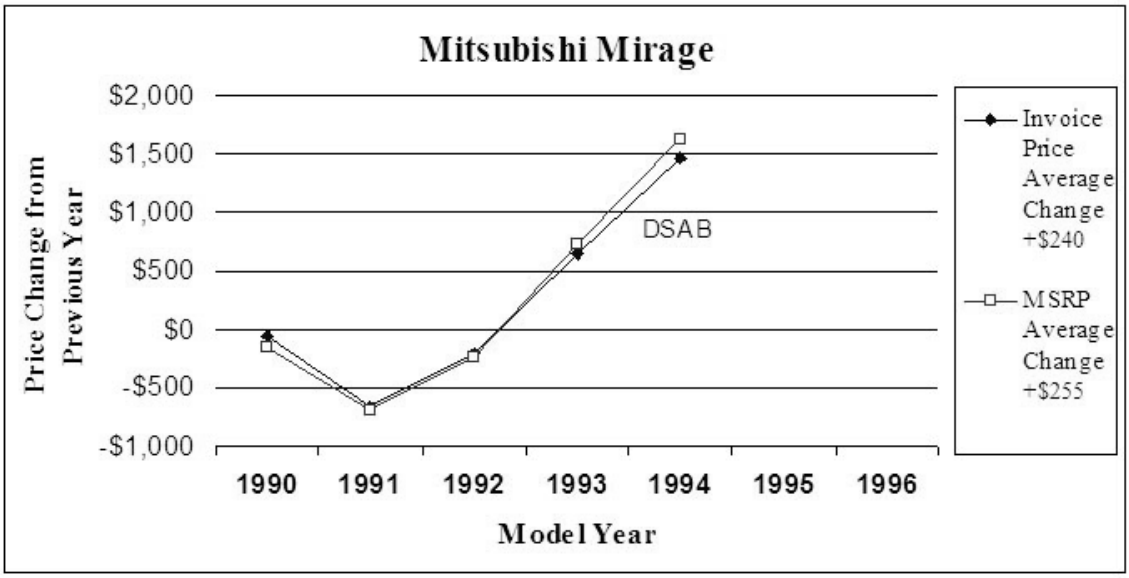
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		21,576	48,894	50,925	53,488	56,982	50,616	51,296	60,469
% of Make		23.7%	32.5%	33.6%	34.3%	35.3%	26.4%	26.6%	36.4%
Inv.	Current$	NA	$9,750	$9,501	$9,852	$10,252	$10,482	$12,497	$13,015
Inv.	2002$	NA	$11,063	$10,411	$10,535	$10,704	$10,582	$12,344	$12,638
MSRP	Current$	NA	$11,104	$10,859	$11,259	$11,719	$11,979	$14,359	$14,970
MSRP	2002$	NA	$12,600	$11,899	$12,039	$12,236	$12,094	$14,183	$14,536

The Eclipse showed virtually no change in price with the exception of the year when dual airbags were made standard on the sporty vehicle. This is a clear-cut example of an automaker attempting to recoup the cost of a regulated technology in the first year it was introduced. Sales remained strong despite the steep price hike, possibly because styling changes were also included in the vehicle's makeover.



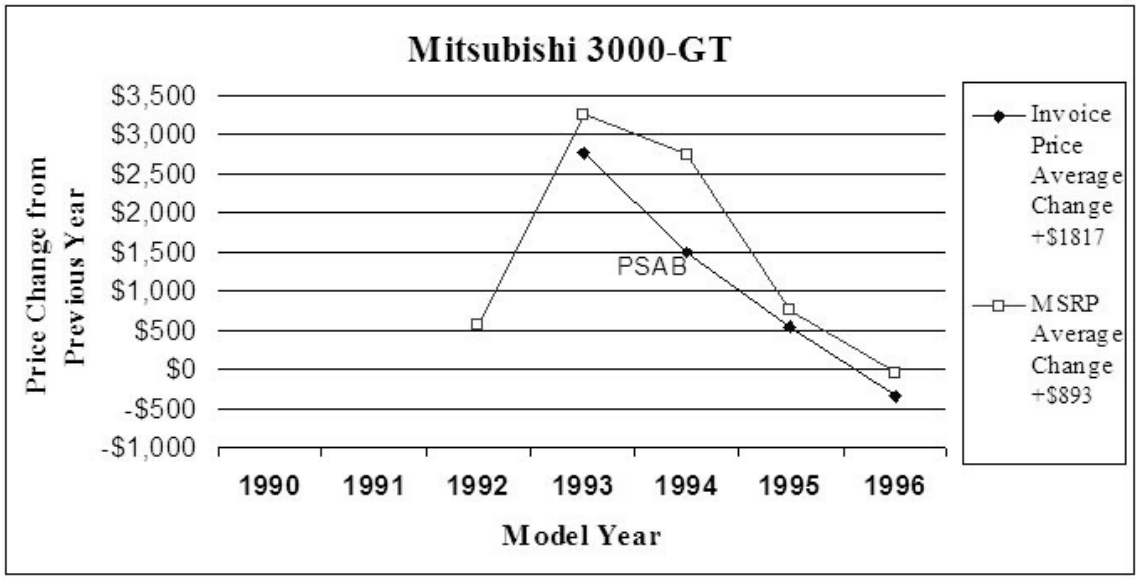
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		27,686	40,739	35,199	28,255	21,847	55,315	62,882	66,373
% of Make		30.4%	27.1%	23.2%	18.1%	13.5%	28.9%	32.6%	40.0%
Inv.	Current$	$9,595	$10,202	$9,909	$10,545	$11,356	$12,104	$12,771	$13,275
Inv.	2002$	$11,052	$11,576	$10,858	$11,276	$11,857	$12,220	$12,615	$12,890
MSRP	Current$	$10,971	$11,287	$10,999	$11,699	$12,599	$13,600	$14,349	$14,920
MSRP	2002$	$12,637	$12,807	$12,052	$12,510	$13,155	$13,730	$14,174	$14,487

Mitsubishi may have eaten some of the cost when dual airbags were made standard in 1994, but sales also rose by more than 2 ½ times, assisted by the presence of the new safety system, as well as, styling changes and a more powerful engine that may have resonated with consumers.



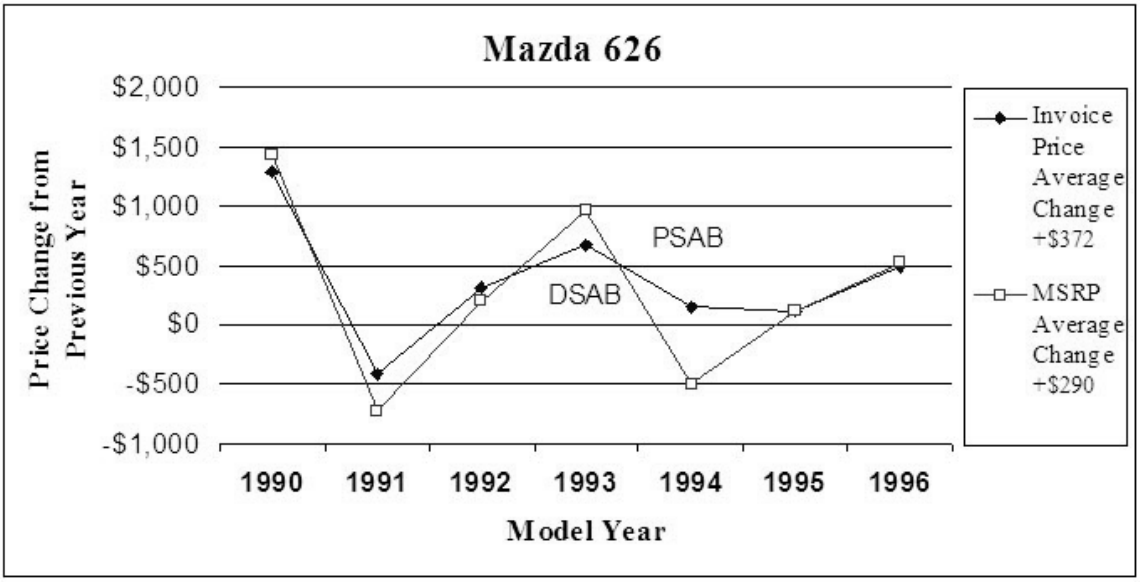
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		18,979	53,692	40,438	21,487	24,982	37,452	51,702	25,875
% of Make		20.8%	35.7%	26.7%	13.8%	15.5%	19.6%	26.8%	15.6%
Inv.	Current$	$7,930	$8,009	$7,692	$7,692	$8,496	$10,237	NA	NA
Inv.	2002$	$9,134	$9,088	$8,429	$8,225	$8,871	$10,335	NA	NA
MSRP	Current$	$8,859	$8,857	$8,549	$8,539	$9,439	$11,369	NA	NA
MSRP	2002$	$10,204	$10,050	$9,368	$9,131	$9,855	$11,478	NA	NA

Mitsubishi made driver-side airbags standard on MY1994 Mirages together with a $1,500 price increase. Sales bounced back for the 1994 and 1995 models despite the price increase.



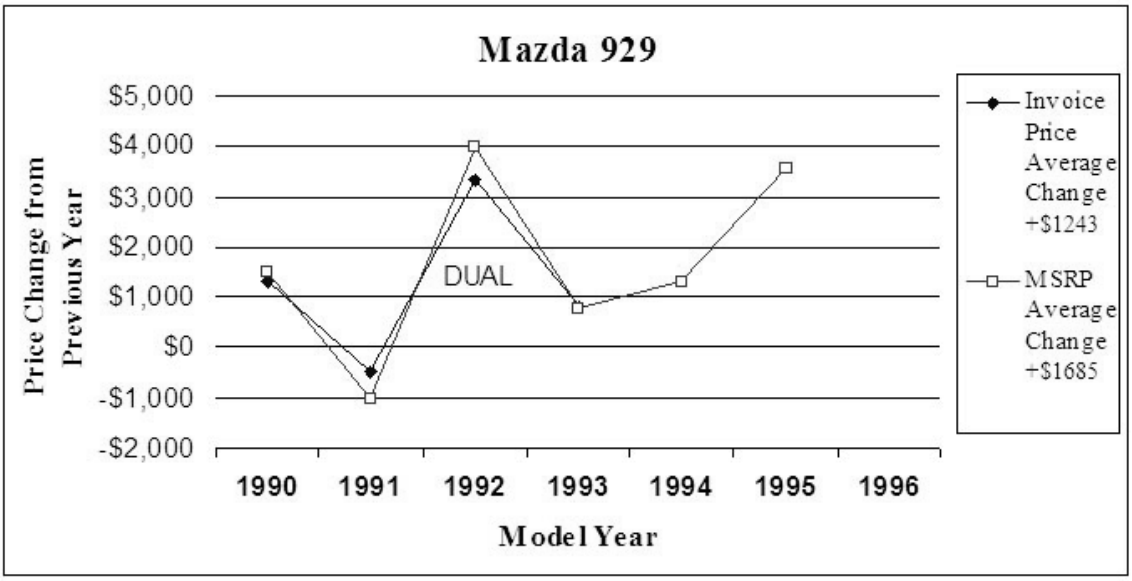
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		-	25	10,575	11,313	13,246	15,353	11,158	8,203
% of Make		0.0%	0.0%	7.0%	7.3%	8.2%	8.0%	5.8%	4.9%
Inv.	Current$	NA	NA	NA	$17,049	$20,111	$22,286	$23,317	$23,372
Inv.	2002$	NA	NA	NA	$18,231	$20,998	$22,499	$23,032	$22,694
MSRP	Current$	NA	NA	$19,059	$20,049	$23,659	$27,175	$28,540	$28,991
MSRP	2002$	NA	NA	$20,884	$21,439	$24,703	$27,435	$28,191	$28,150

Large MSRP increases, totaling about $6,000, were made the year previous to and the year of the introduction of a passenger-side airbag. Sales peaked during these two years when prices grew most rapidly. Part of Mitsubishi's airbag cost recovery strategy may have involved very large price hikes on price-neutral models such as the 3000 GT, and more stability on the more price-sensitive models such as the Galant.



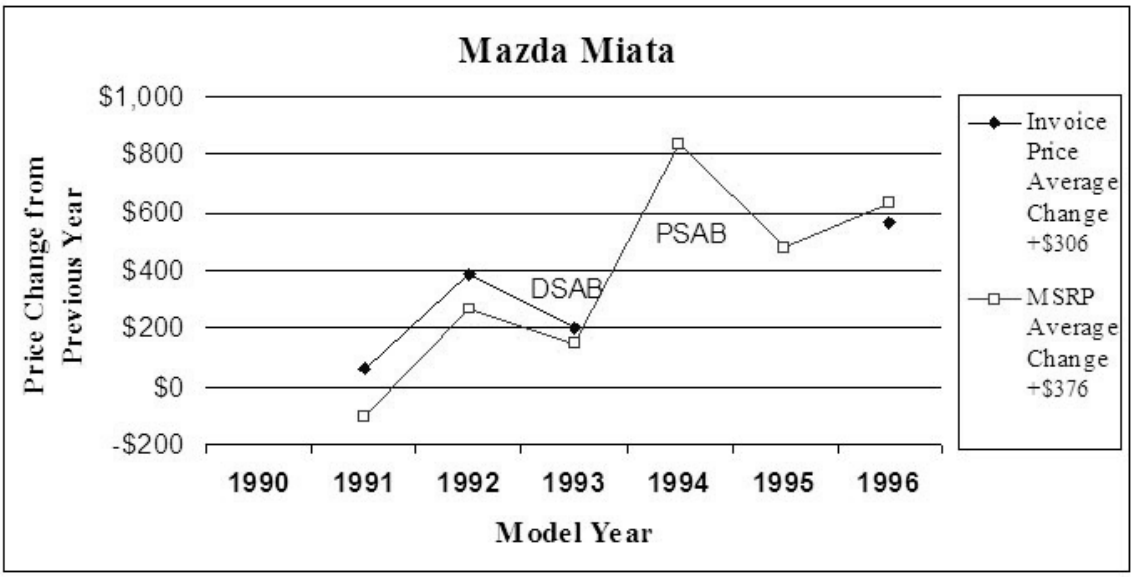
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		57,495	64,420	68,496	50,320	66,160	81,210	99,086	81,638
% of Make		25.1%	28.1%	30.7%	21.2%	26.4%	28.7%	40.0%	42.8%
Inv.	Current$	$9,774	$11,056	$11,063	$11,627	$12,557	$13,134	$13,540	$14,277
Inv.	2002$	$11,258	$12,545	$12,123	$12,433	$13,111	$13,260	$13,374	$13,863
MSRP	Current$	$11,299	$12,738	$12,529	$13,025	$14,255	$14,255	$14,695	$15,495
MSRP	2002$	$13,015	$14,454	$13,729	$13,928	$14,884	$14,391	$14,515	$15,046

The 626 also exhibits substantial price volatility. When driver-side airbags were made standard there was a $1,000 rise in MSRP, but the following year when passenger-side airbags were introduced, MSRP declined by $500, while inventory price increased slightly. There are clearly corporate objectives related to profit maximization and market share preservation of the company's most popular passenger car that inform pricing policy more than straight cost recovery from airbags.



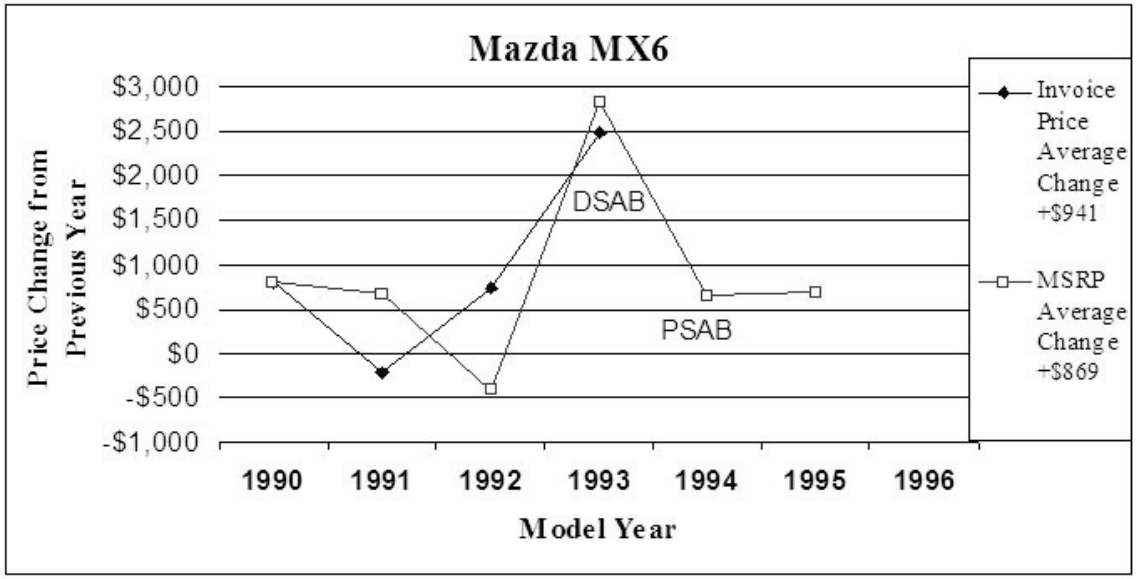
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		20,794	16,938	14,151	21,398	18,122	13,003	5,153	1,627
% of Make		9.1%	7.4%	6.3%	9.0%	7.2%	4.6%	2.1%	0.9%
Inv.	Current$	$18,194	$19,618	$19,880	$23,492	$24,835	NA	$30,802	NA
Inv.	2002$	$20,957	$22,261	$21,784	$25,120	$25,930	NA	$30,425	NA
MSRP	Current$	$21,920	$23,579	$23,500	$27,800	$29,200	$31,500	$35,795	NA
MSRP	2002$	$25,248	$26,755	$25,751	$29,727	$30,488	$31,801	$35,357	NA

The 929 is Mazda's luxury sedan and is not subject to the degree of price sensitivity of the 626, MX6, or 323. For this reason, dual airbags were accompanied by a $4,000 increase in MSRP. The inventory cost only grew by about $3,300, which gave dealers room to deal if consumers reacted adversely to the price increase. Sales peaked during this year, which may be due to the inclusion of an airbag system, or possibly because consumers in this market segment associate price positively with added features and prestige.



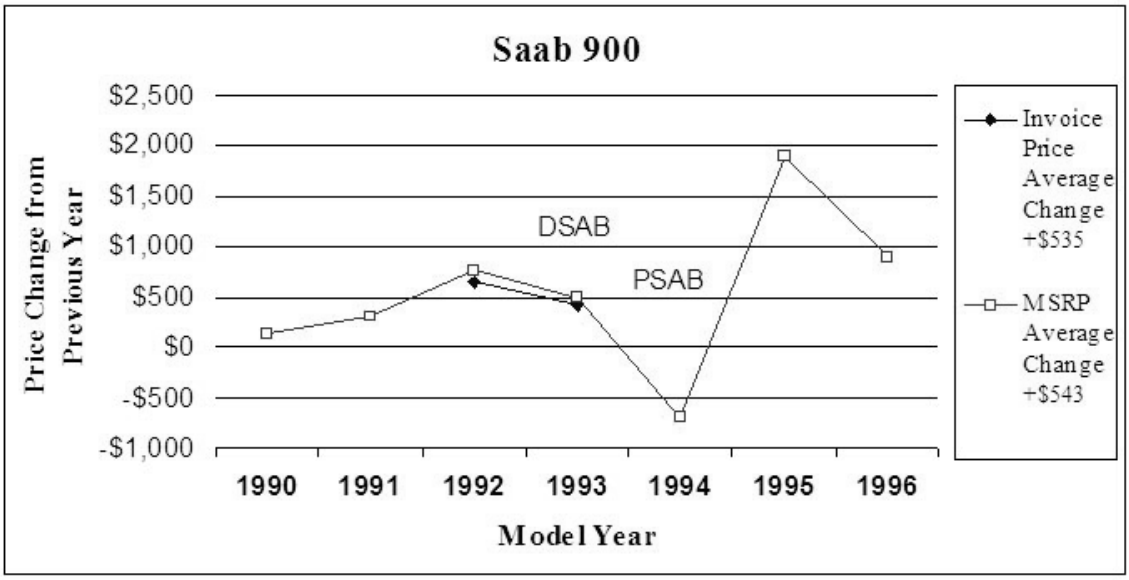
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		13,525	38,133	34,610	24,847	22,350	22,705	20,790	17,984
% of Make		5.9%	16.6%	15.5%	10.4%	8.9%	8.0%	8.4%	9.4%
Inv.	Current$	NA	$11,963	$12,449	$13,119	$13,632	NA	$15,768	$16,624
Inv.	2002$	NA	$13,575	$13,641	$14,028	$14,233	NA	$15,575	$16,142
MSRP	Current$	NA	$13,800	$14,200	$14,800	$15,300	$16,650	$17,500	$18,450
MSRP	2002$	NA	$15,659	$15,560	$15,826	$15,975	$16,809	$17,286	$17,915

The Miata is a budget two-seater. When driver-side airbags were made standard for the 1993 model year, there was only a small price increase. The following year when a passenger-side airbag was added, there was a significant price increase of $800, which could presumably recover the entire airbag system cost.



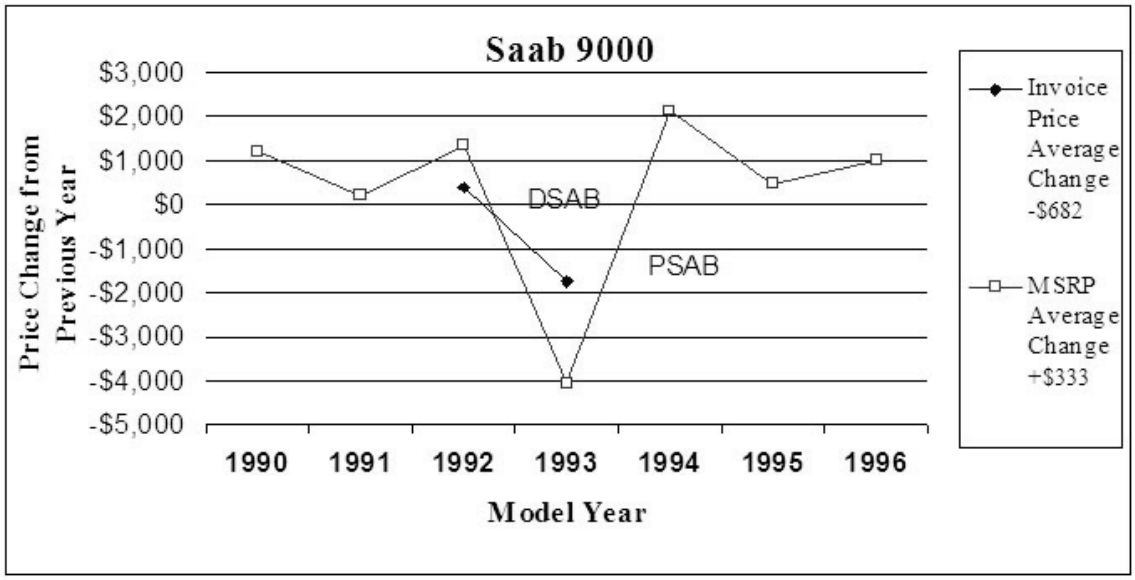
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		43,522	30,435	25,402	22,020	29,676	22,740	17,883	7,957
% of Make		19.0%	13.3%	11.4%	9.3%	11.8%	8.0%	7.2%	4.2%
Inv.	Current$	$9,746	$10,594	$10,765	$11,707	$14,358	NA	$16,546	NA
Inv.	2002$	$11,226	$12,021	$11,796	$12,518	$14,991	NA	$16,344	NA
MSRP	Current$	$11,399	$12,279	$13,329	$13,265	$16,300	$17,495	$18,573	NA
MSRP	2002$	$13,130	$13,933	$14,606	$14,184	$17,019	$17,662	$18,346	NA

Apparently, the MX6 does not exhibit as much price sensitivity as most cars in its market segment. When driver-side airbags were introduced alongside a more powerful engine and new styling features, the price skyrocketed by nearly $3,000. Sales increased as well. For some reason, the MX6 could absorb the added cost, which helped Mazda partially recoup the costs due to airbags from other lines as well.



Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		24,536	17,458	16,499	15,785	11,630	14,236	20,055	21,283
% of Make		70.9%	67.6%	62.4%	61.6%	57.4%	68.7%	77.0%	76.6%
Inv.	Current$	$14,800	NA	$15,899	$16,896	$17,711	NA	$20,687	NA
Inv.	2002$	$17,047	NA	$17,422	$18,067	$18,492	NA	$20,434	NA
MSRP	Current$	$17,515	$17,898	$18,815	$19,995	$20,960	$20,990	$23,375	$24,695
MSRP	2002$	$20,175	$20,309	$20,617	$21,381	$21,884	$21,191	$23,089	$23,979

The Saab 900 is more price sensitive than its more luxurious counterpart, the 9000. A price drop of $500 for the 900 accompanied the passenger-side airbag, but in the case of the 9000, there was a $2000 price increase. The addition of the driver-side airbag the previous year saw the opposite dynamic – the 9000 had a large price drop while the 900 was given a significant price increase. Saab did this price jockeying to maximize sales and profits, while at the same time recouping compliance costs.



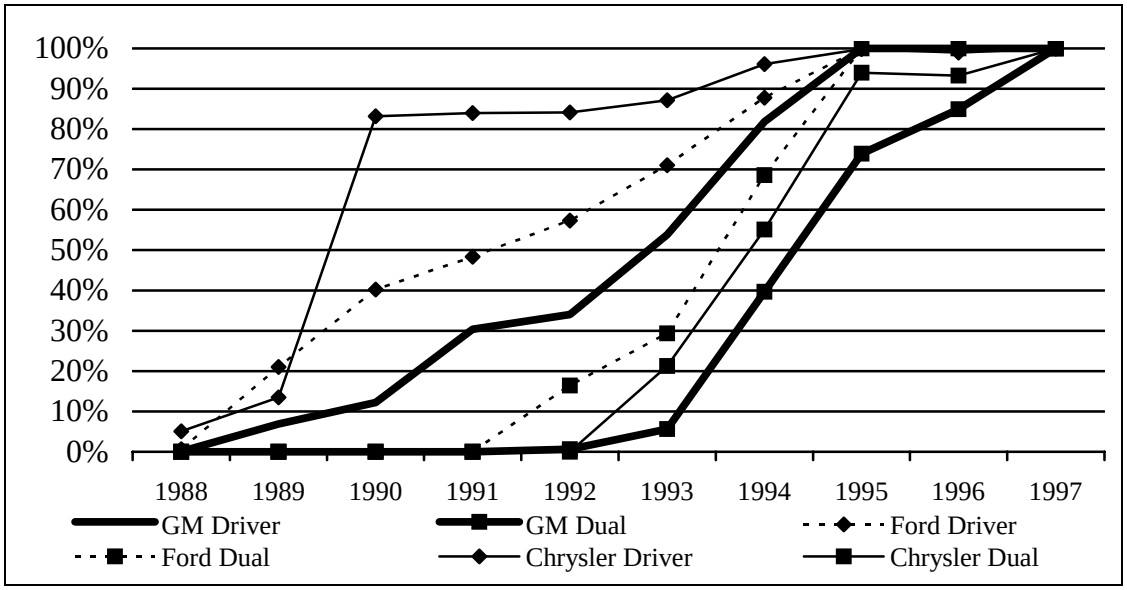
Year		1989	1990	1991	1992	1993	1994	1995	1996
Sales		10,089	8,351	9,951	9,838	8,637	6,498	5,999	6,501
% of Make		29.1%	32.4%	37.6%	38.4%	42.6%	31.3%	23.0%	23.4%
Inv.	Current$	$20,167	NA	$22,325	$23,235	$22,123	NA	$26,338	NA
Inv.	2002$	$23,229	NA	$24,463	$24,846	$23,099	NA	$26,016	NA
MSRP	Current$	$24,445	$25,878	$26,995	$28,905	$25,725	$28,725	$29,845	$31,395
MSRP	2002$	$28,157	$29,364	$29,580	$30,909	$26,860	$29,000	$29,480	$30,485

The sales of the 9000 lagged during this period as it awaited a styling and performance makeover. The relative low demand for the 9000 kept price changes to a minimum and as a result it had a smaller average MSRP change than the 900. The price increases during the year the passenger-side airbag was introduced and the two following years indicates that Saab may have been recovering costs that resulted from compliance.

APPENDIX B: DETAILED AIRBAG AND ABS INSTALLATION RATES

Note: All of the below graphs represent the percentage of passenger cars sold in the U.S. with the specified factory installed attribute. The source for these data is *Ward's Automotive Yearbook*.

Big 3 Airbag Installation Rates



Japanese Big 3 Airbag Installation Rates

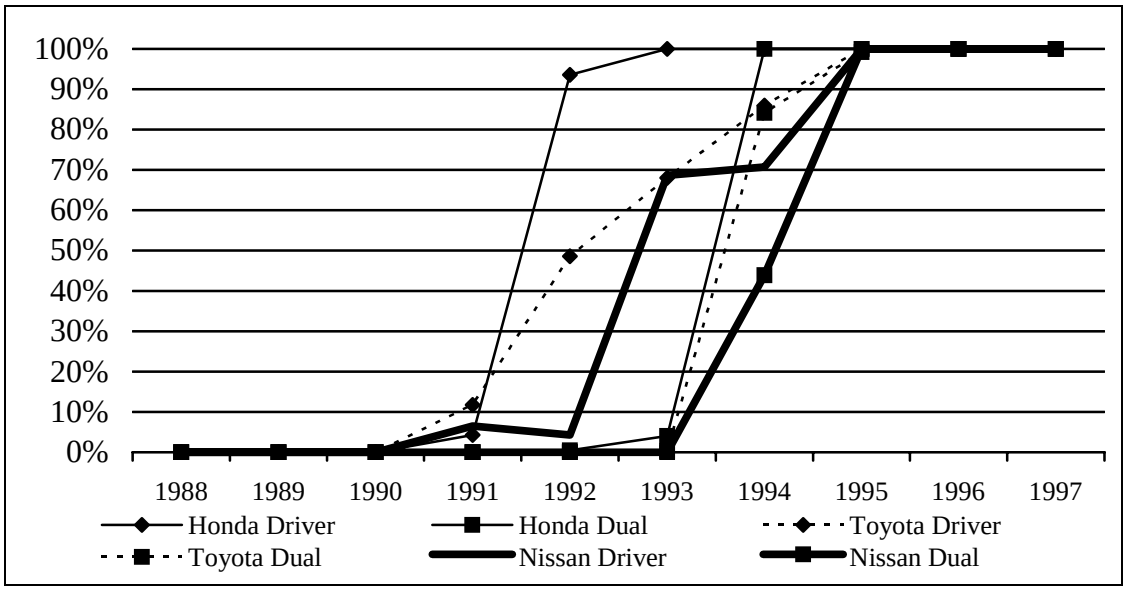
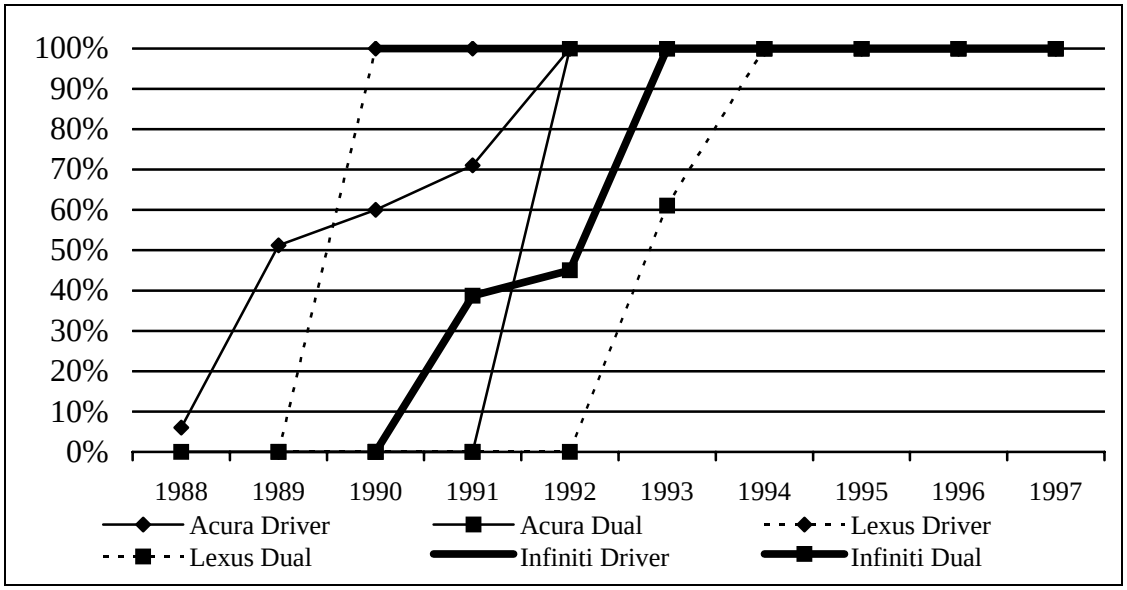
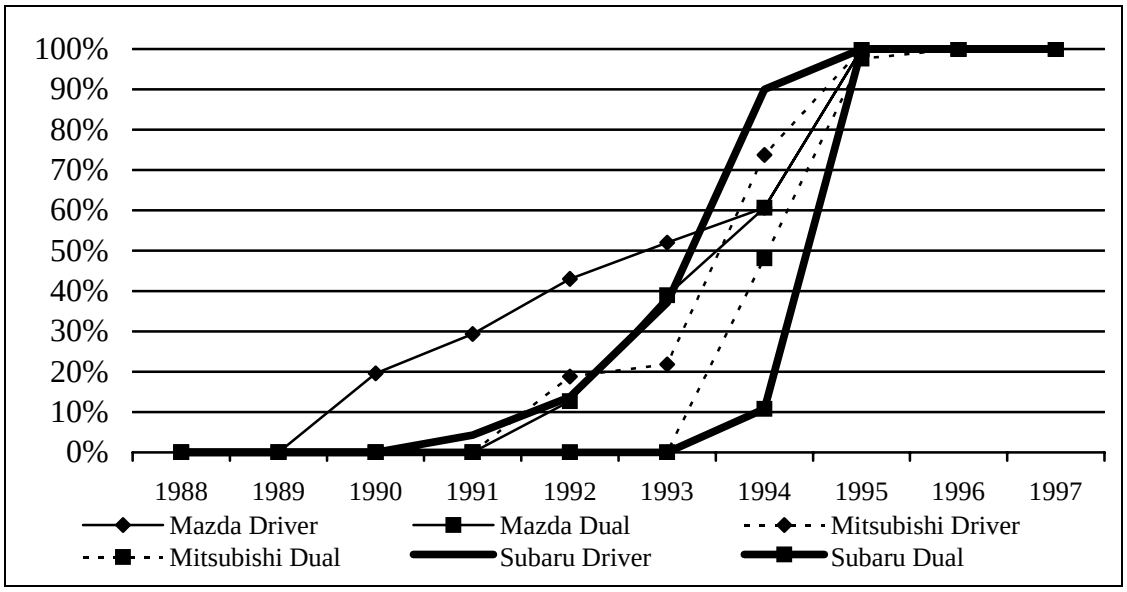


Figure Note: Does not include luxury divisions of the Japanese automakers (i.e. Acura, Lexus, Infiniti)

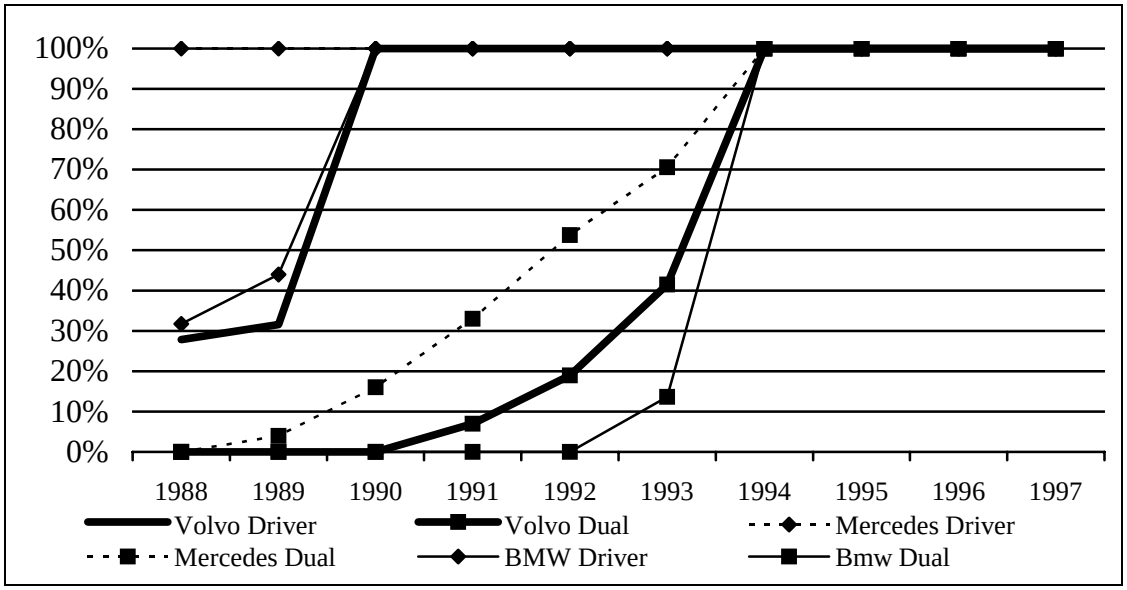
Japanese Big 3 Luxury Divisions Airbag Installation Rates



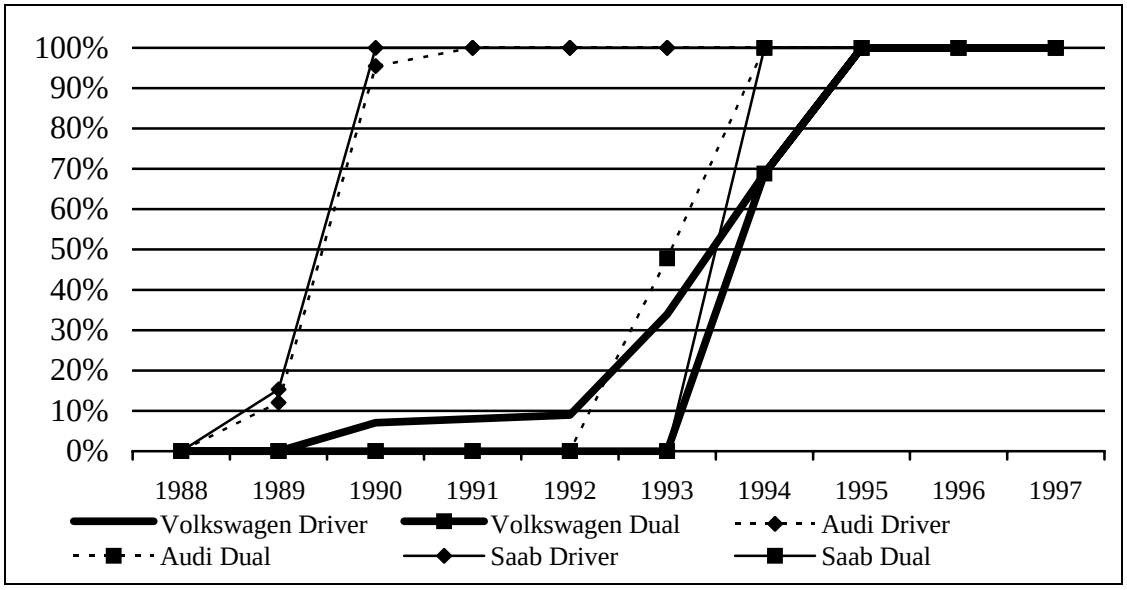
Other Japanese Automaker Airbag Installation Rates



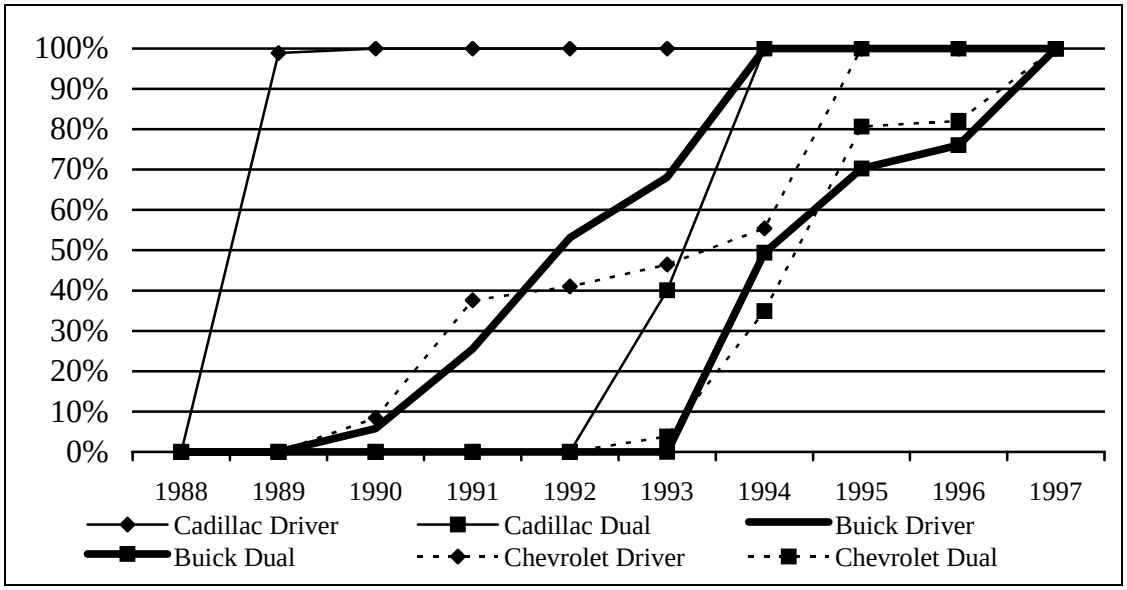
Luxury European Automaker Airbag Installation Rates



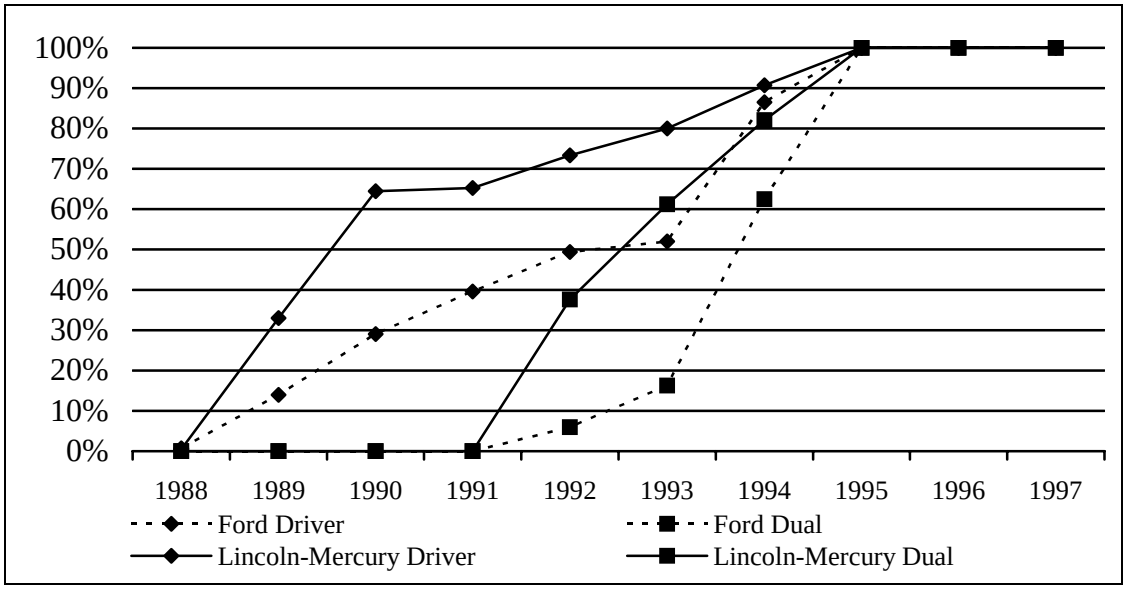
Additional European Automaker Airbag Installation Rates



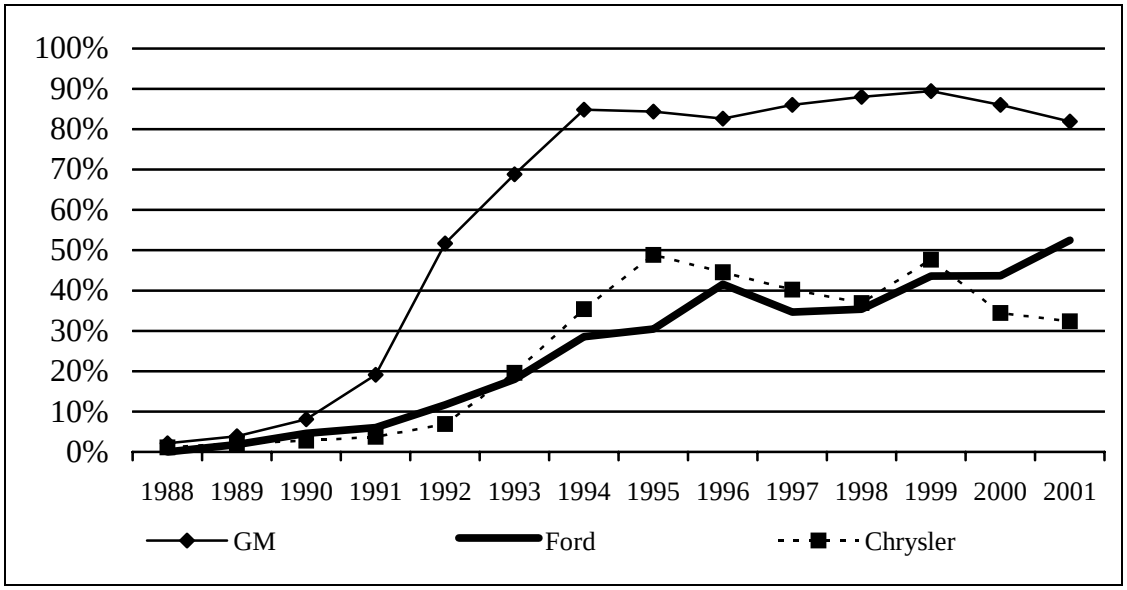
GM Airbag Installation Rates by Division



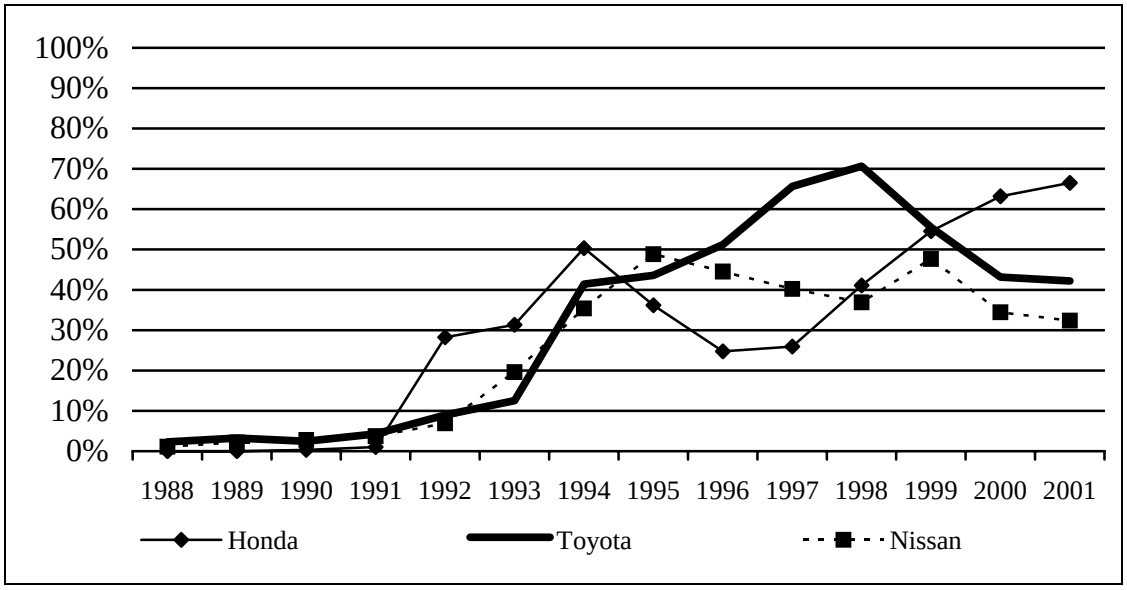
Ford Airbag Installation Rates by Division



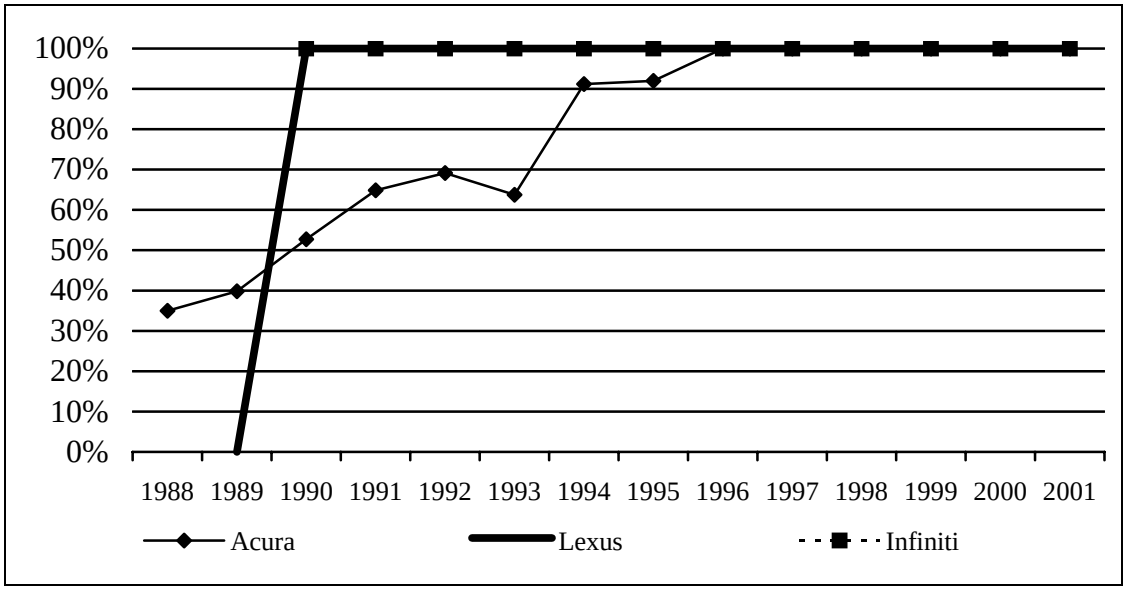
Big 3 ABS Installation Rates



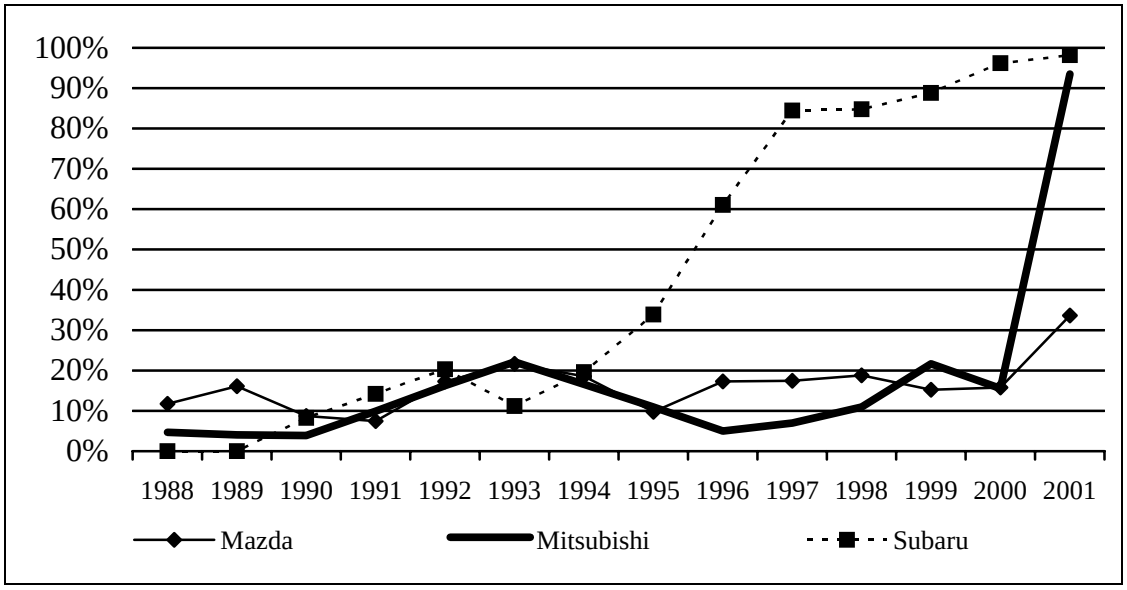
Japanese Big 3 ABS Installation Rates



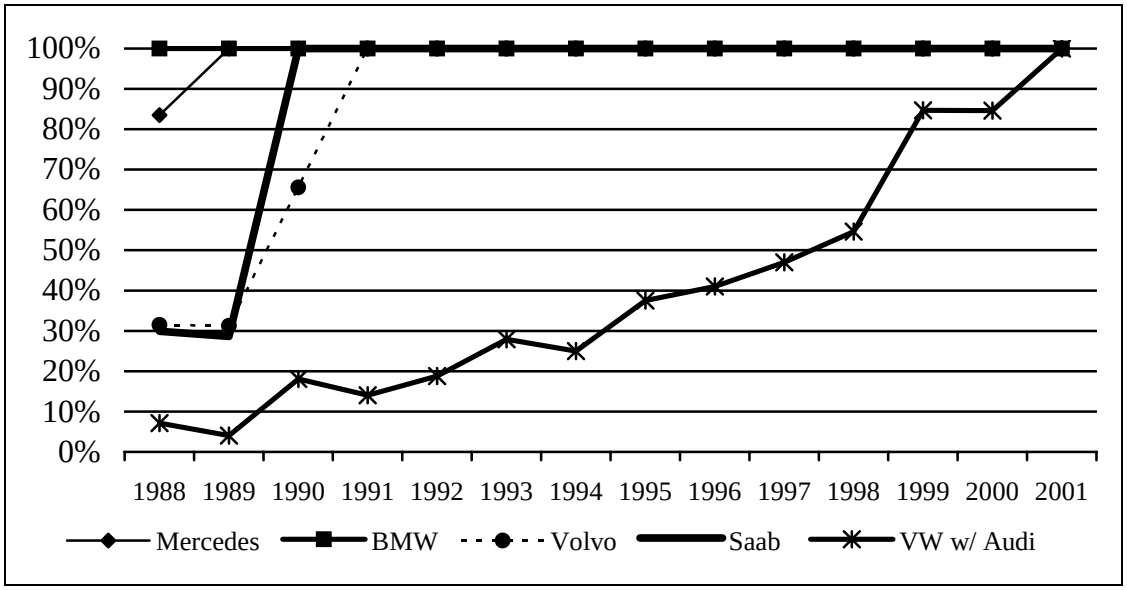
Japanese Luxury Big 3 ABS Installation Rates



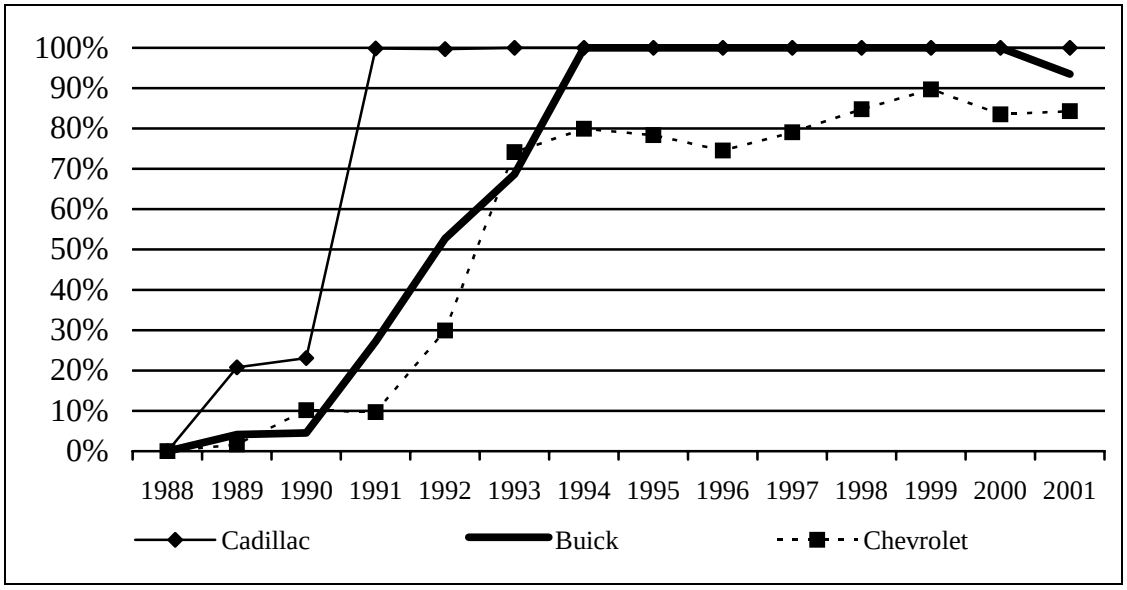
Other Japanese Automaker ABS Installation Rates



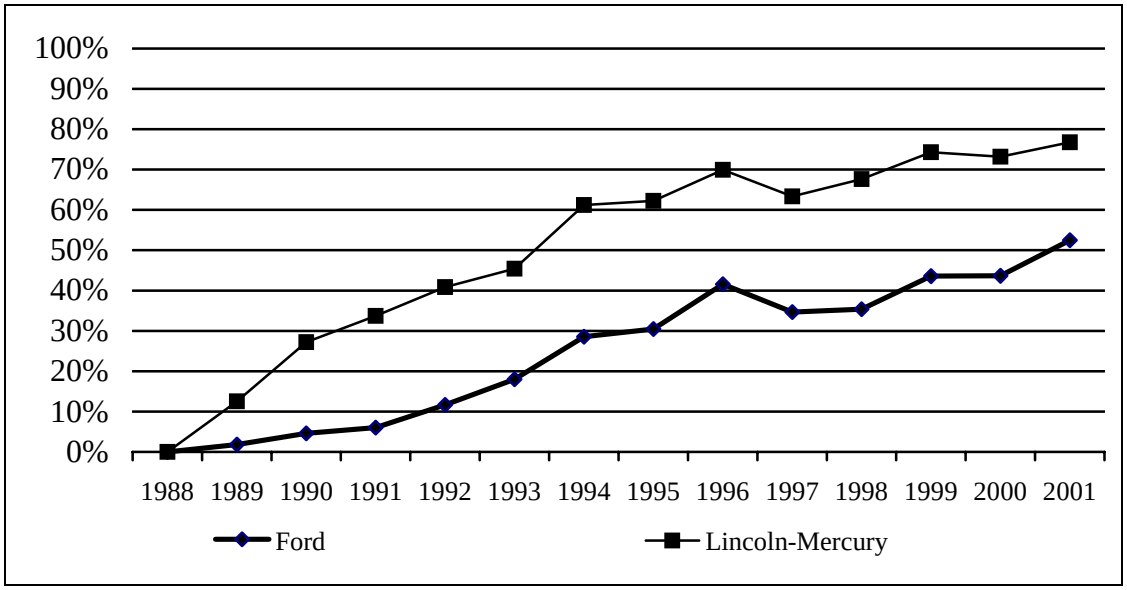
European Automaker ABS Installation Rates



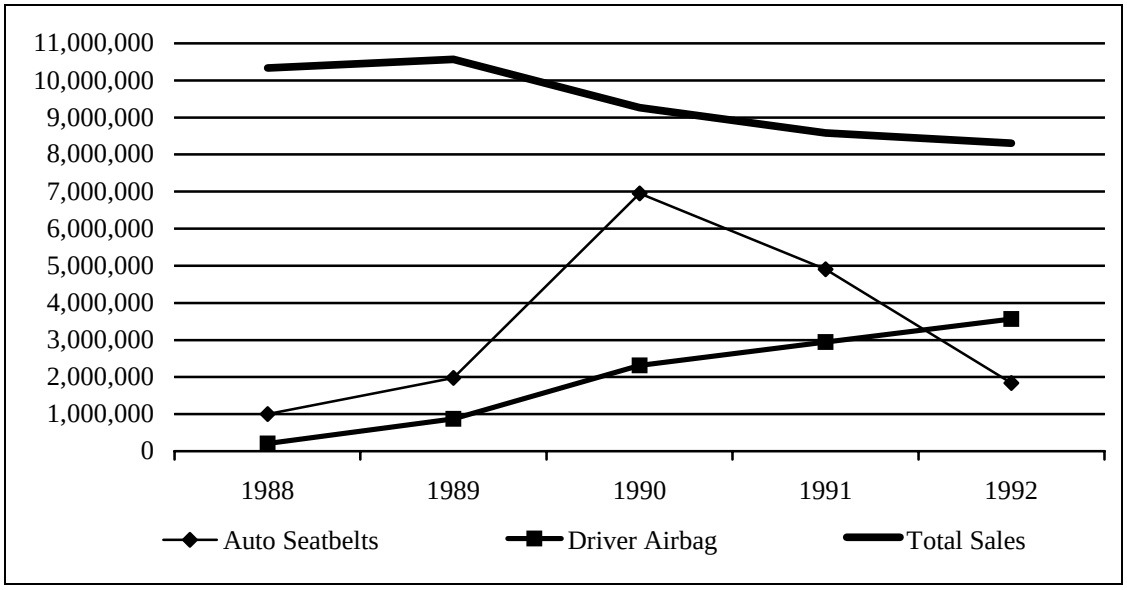
GM ABS Installation Rates by Division



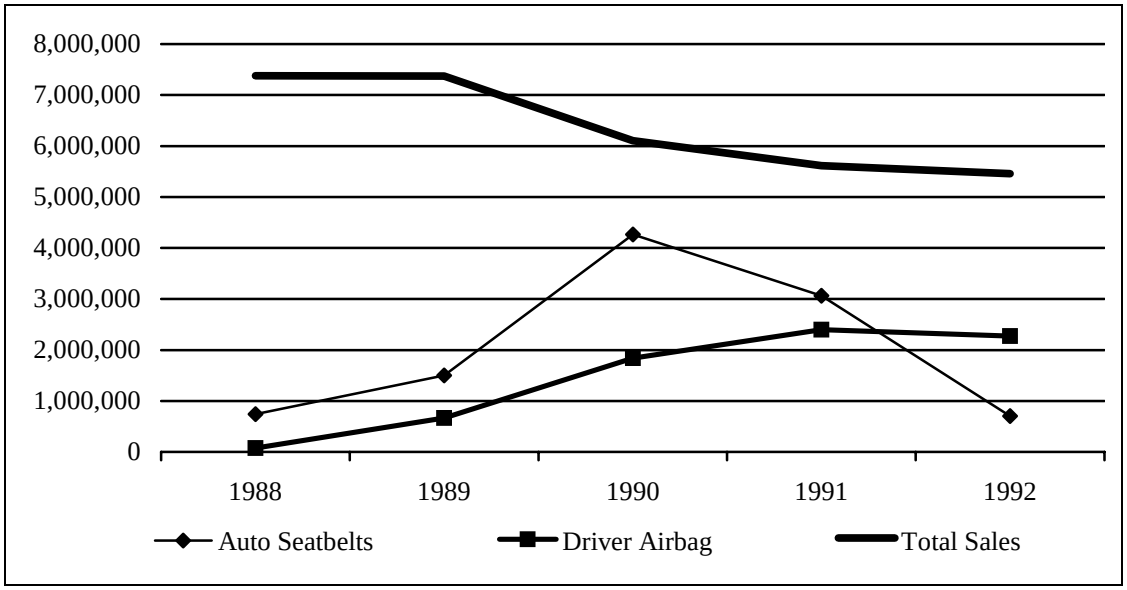
Ford ABS Installation Rates by Division



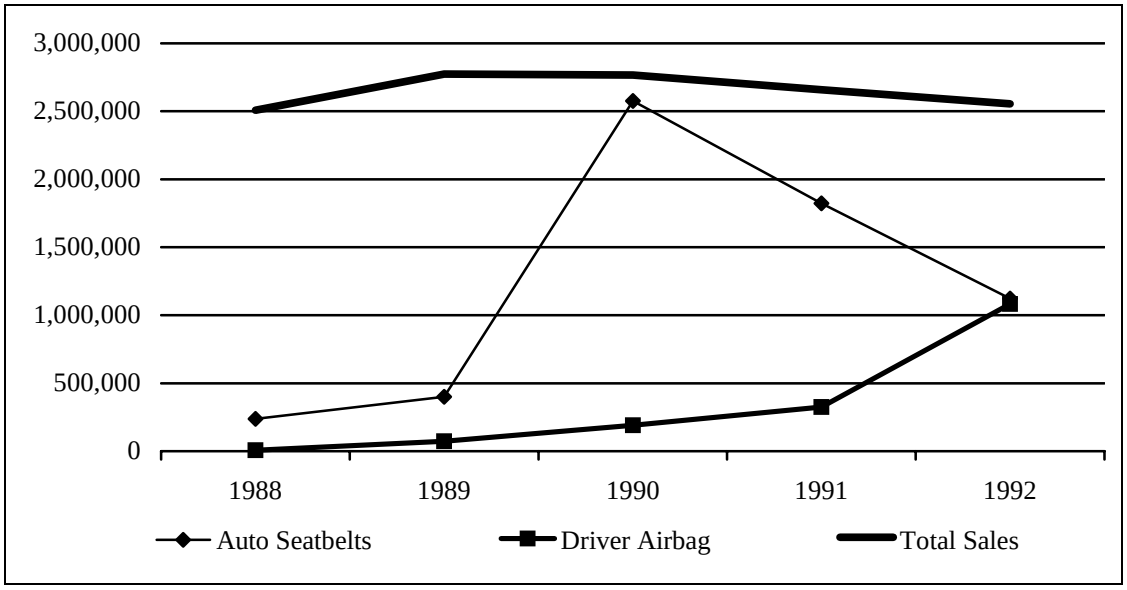
Passive Restraint Installation Trends and Total Passenger Car Sales (All Cars)



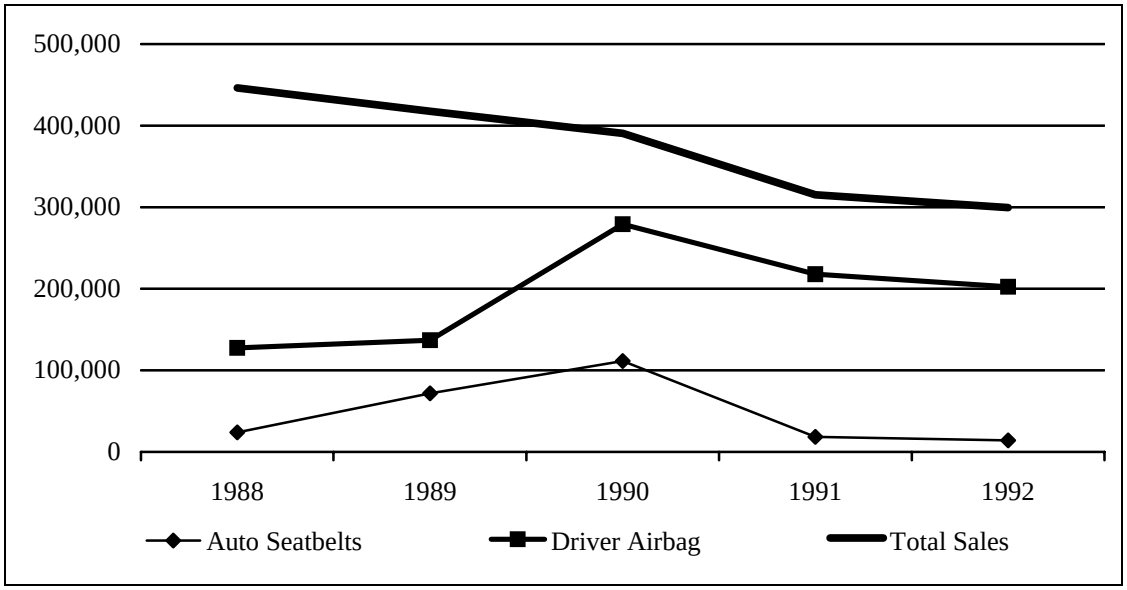
Passive Restraint Installation Trends and Total Passenger Car Sales (Big 3)



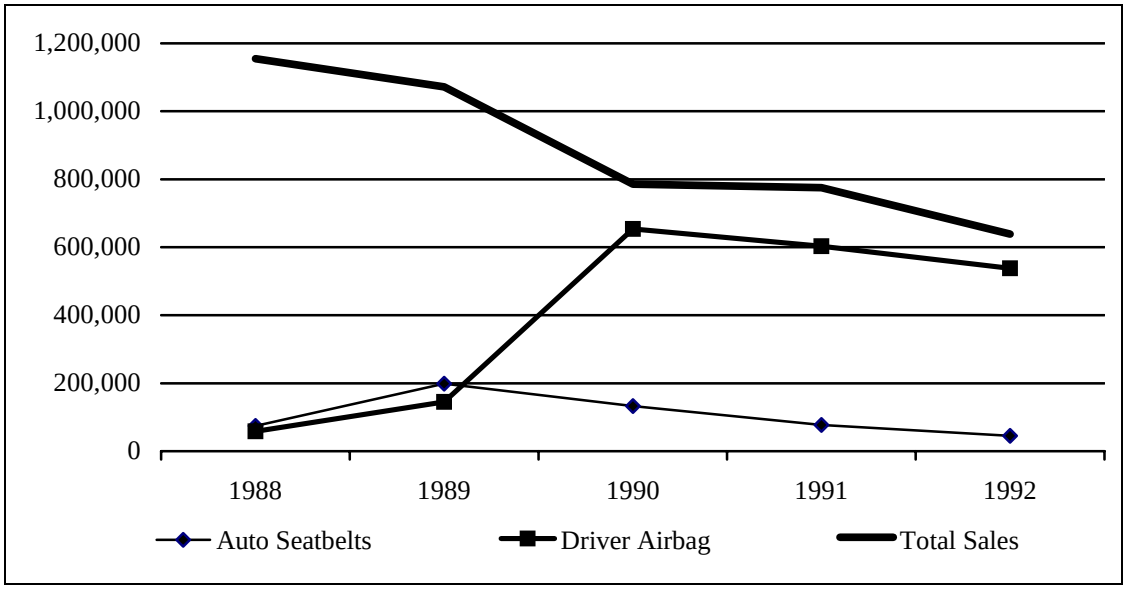
Passive Restraint Installation Trends and Total Passenger Car Sales (Asia)



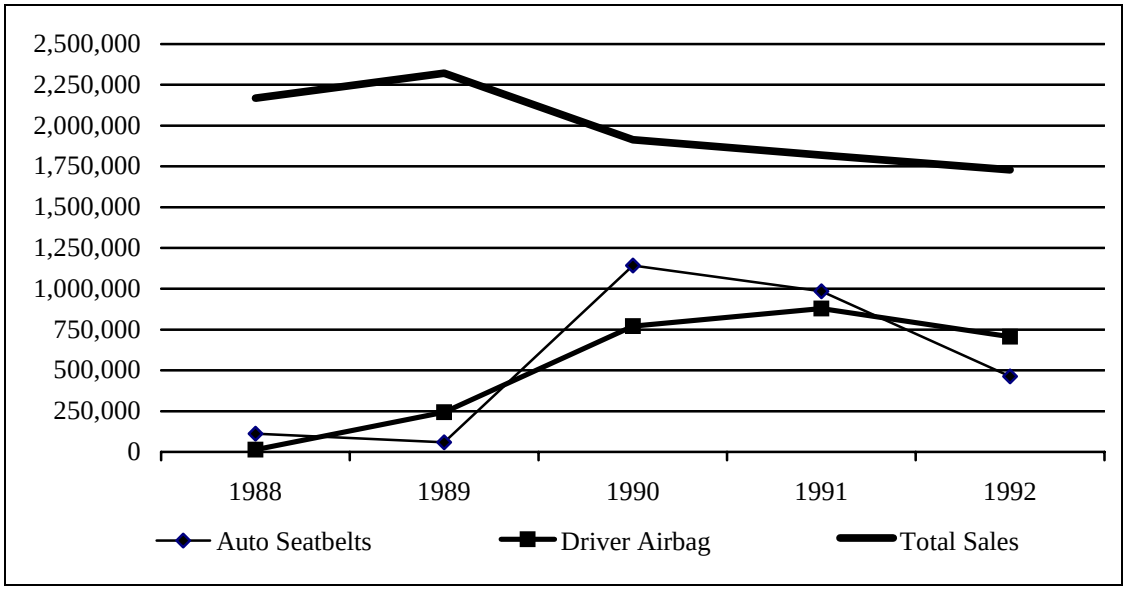
Passive Restraint Installation Trends and Total Passenger Car Sales (Europe)



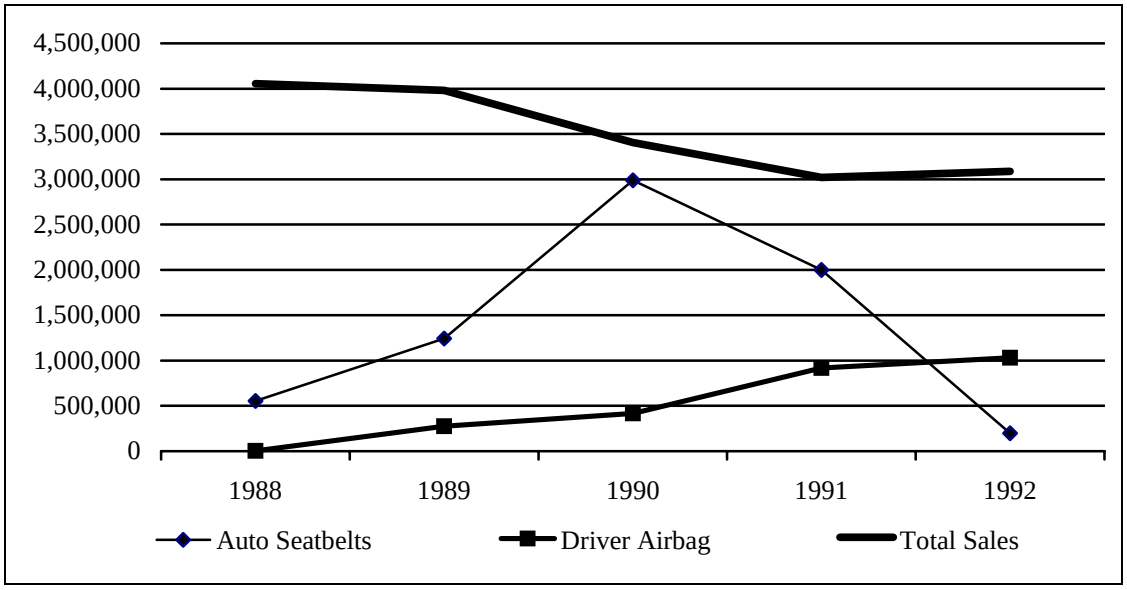
Passive Restraint Installation Trends and Total Passenger Car Sales (Chrysler)



Passive Restraint Installation Trends and Total Passenger Car Sales (Ford)



Passive Restraint Installation Trends and Total Passenger Car Sales (GM)



APPENDIX C: DESCRIPTIVE STATISTICS FOR PRICE ANALYSIS

All Vehicles

Category	n	mean	Minimum	Maximum	Standard Deviation
Small Car	152	268	-4051	3394	774
Midsize Car	75	449	-3062	5024	1148
Large Car	58	572	-2601	4043	1050
Luxury Car	154	685	-5449	7682	1863
Sports Car	56	674	-3240	5060	1251
Minivan	12	1448	-311	3384	1144
SUV	47	1433	-1879	6590	1830
< 15k	165	386	-1747	5060	785
15k – 25k	205	581	-4051	6590	1281
> 25k	184	830	-5449	7682	1877
Average All Vehicles	554	606	-5449	7682	1409

Driver-Side Airbag is made Standard

Category	n	mean	Minimum	Maximum	Standard Deviation
Small Car	23	370	-774	3394	830
Midsize Car	12	1175	379	5024	1279
Large Car	7	1487	0	4043	1245
Luxury Car	16	955	-3027	5107	1796
Sports Car	8	551	-1858	3361	1556
Minivan	2	1866	1831	1900	48.8
SUV	6	1208	560	2074	687
< 15k	24	393	-774	3394	819
15k – 25k	30	1055	-1858	5024	1248
> 25k	20	1129	-3027	5107	1699
Average All Vehicles	74	861	-3027	5107	1299

Passenger-Side Airbag is made standard

Category	n	mean	Minimum	Maximum	Standard Deviation
Small Car	14	-296	-3360	1248	1136
Midsize Car	6	1185	287	4090	1463
Large Car	6	1035	-730	2431	553
Luxury Car	30	1170	-2762	4658	1636
Sports Car	7	1023	-3240	3019	2067
Minivan	2	1658	1584	1732	105
SUV	7	1827	325	5978	2008
< 15k	12	-311	-3240	1248	1187
15k – 25k	23	799	-3360	4090	1411
> 25k	37	1351	-2762	5978	1719
Average All Vehicles	72	898	-3360	5978	1640

ABS is made standard

Category	n	mean	Minimum	Maximum	Standard Deviation
Small Car	18	1502	-55	3162	1142
Midsize Car	13	464	-1864	1509	822
Large Car	11	1445	67	4043	1086
Luxury Car	24	1159	-1207	5979	1582
Sports Car	8	927	-376	2612	1054
Minivan	11	912	-2058	3422	1514
SUV	18	1351	-49	5222	1428
< 15k	35	770	-1410	3144	993
15k – 25k	70	1148	-1864	5222	1145
> 25k	26	1135	-2058	5979	1728
Average All Vehicles	131	1045	-2058	5979	1247

APPENDIX D: BUREAU OF LABOR STATISTICS NEW CAR QUALITY IMPROVEMENTS 1968 – 2002

Year	*Average Retail Equivalent Price of All Motor Vehicle Quality Changes for New Cars*		*Average Change in MSRP for New Cars from Previous Year from BLS*		*Average Change in Transaction Price for New Cars*
	(Current $)	(2000 $)	(Current $)	(2000 $)	(2000$)
1969	$1.00	$4.69	$40.00	$187.68	NA
1970	$46.00	$204.15	$107.00	$474.88	NA
1971	-$6.00	-$25.51	-$15.17	-$64.50	$190
1972	$20.00	$82.39	-$1.00	-$4.12	$70
1973	$123.80	$480.14	NA	NA	-$265
1974	$117.90	$411.81	NA	NA	-$207
1975	$129.90	$415.78	$386.00	$1,235.49	$336
1976	$15.60	$47.21	$198.00	$599.22	$553
1977	$59.15	$168.08	$382.30	$1,086.34	$124
1978	$50.12	$132.37	$424.49	$1,121.12	$327
1979	$46.35	$109.94	$300.30	$712.28	-$607
1980	$241.51	$504.71	$365.85	$764.56	-$412
1981	$530.85	$1,005.64	$536.14	$1,015.66	$1,051
1982	$126.32	$225.41	$562.64	$1,004.01	$769
1983	$128.04	$221.37	$263.92	$456.30	$689
1984	$110.08	$182.44	$221.70	$367.44	$516
1985	$151.45	$242.38	$268.20	$429.22	$92
1986	$186.50	$293.02	$745.52	$1,171.34	$933
1987	$47.13	$71.44	$776.38	$1,176.87	$413
1988	$245.56	$357.44	$458.66	$667.64	-$11
1989	$182.89	$253.98	$559.35	$776.77	-$323
1990	$216.40	$285.11	$804.91	$1,060.49	-$139
1991	$215.06	$271.90	$672.77	$850.59	-$253
1992	$259.79	$318.86	$917.30	$1,125.87	$485
1993	$89.10	$106.18	$616.54	$734.73	$55
1994	$363.63	$422.52	$612.74	$711.97	$697
1995	$173.35	$195.87	$543.21	$613.78	-$510
1996	$193.03	$211.85	$494.98	$543.25	$316
1997	$185.53	$199.05	$333.34	$357.64	$347
1998	$230.81	$243.84	$363.27	$383.77	$558
1999	$15.50	$16.02	$125.27	$129.48	-$161
2000	$169.05	$169.05	$408.42	$408.42	-$997
		$206.79			
2001	$212.67		$422.51	$410.82	$652
		$65.38		$361.76	
2002	$63.80		$377.94		NA

APPENDIX E: DESCRIPTION OF AIRBAG RELATED PATENT SUBCLASSES

728.1 Inflatable passenger restraint or confinement (e.g., air bag) or attachment:
This subclass is indented under subclass 727. Devices wherein the attachment comprises a bag designed to inflate upon impact of the vehicle with an external object and thereby confine a vehicle occupant in a protective environment made up of a confinement bag and a vehicle seat.

(1) Note. A passenger-restraining device of the inflatable type is provided for only in this class (280).

728.2 With specific mounting feature:
This subclass is indented under subclass 728.1. Devices combined with means to connect: (a) the bag housing to a vehicle, (b) the bag to a housing or an inflator or (c) an inflator to a housing.

728.3 Deployment door:
This subclass is indented under subclass 728.1. Devices having a cover or lid which opens upon inflation of the bag.

729 Plural compartment confinement (e.g., "bag within a bag")
Devices under subclasses 728.1+ wherein the confinement (air bag) is made of a plurality of individual compartments or is made of two or more bags, one within the other.

730.1 Inflated confinement specially positioned relative to occupant or conforming to the body shape of occupant:
This subclass is indented under subclass 728.1. Devices wherein the confinement, when inflated, is (a) positioned in a particular manner with respect to the occupant"s body or (b) is shaped or contoured with respect to a particular part of the occupant"s body.

730.2 Mounted in vehicle and positioned laterally of occupant:
This subclass is indented under subclass 730.1. Devices wherein the confinement is stored during its nonuse or uninflated condition within the vehicle at the side of the occupant.

731 Deflated confinement located within or on steering column
Devices under subclasses 728.1+ wherein the confinement is stored in its nonuse or deflated condition within or on the vehicle steering column.

732 Deflated confinement located in or on instrument panel
Devices under subclasses 728.1+ wherein the confinement is stored in its nonuse or deflated condition within or on the vehicle instrument panel or "dash-board".

733 In the form of or used in conjunction with a belt or strap
Devices under subclasses 728.1+ wherein the inflatable confinement is 1) shaped as or resembles a belt, strap or harness arrangement and/or 2) is combined with a belt, strap or harness arrangement.

734 Responsive to vehicle condition
Devices under subclasses 728.1+ which are inflated in response to one or more particular vehicle conditions which assume impending collision or crash.

735 Electric control and/or sensor means
This subclass is indented under subclass 734. Devices wherein the confinement inflation initiation means and or condition sensor is electrical.

736 With source of inflation fluid and flow control means thereof
Devices under subclasses 728.1+ having an inflation fluid source or generator and the means to control such fluid flow from the source to the confinement or to the atmosphere or such fluid flow from the confinement to the atmosphere.

737 With means to rupture or open fluid source
This subclass is indented under subclass 736. Devices provided with means to open or rupture a closure in the fluid source to allow the inflation fluid to flow to the confinement.

738 With means to aspirate ambient air
This subclass is indented under subclass 736. Devices having means to draw ambient air into the flow line and mix such air with the inflation fluid, such mixture being the total or resultant inflation fluid which fills the confinement.

739 With confinement deflation means
This subclass is indented under subclass 736. Devices provided with means to deflate the confinement after inflation thereof.

740 With means to diffuse inflation fluid
This subclass is indented under subclass 736. Devices wherein the confinement is provided with means to diffuse or deflect the stream of inflation fluid, thereby spreading the stream of inflation fluid from a single point to a more general area within the confinement.

741 Inflation fluid source
Devices under subclasses 728.1+ having a specific inflation fluid source or generator therefore.

742 Flow control means

Devices under subclasses 728.1+ having a specific inflation fluid control therefore.

743.1 Specific confinement structure:

This subclass is indented under subclass 728.1. Devices wherein the confinement or the bag is provided with a specific shape or is defined by its specific structure.

743.2 With confinement expansion regulating tether or strap:

This subclass is indented under subclass 743.1. Devices combined with a strip or band which controls the inflation of the bag to conform to a certain shape or limit the extension of the bag.

APPENDIX F: COST FIGURING METHODOLOGY FOR NHTSA-SPONSORED STUDIES AND REPORTED AIRBAG COSTS

The three reports responsible for the data provided in Table 3-3 are representative cost analysis studies as contracted by NHTSA. The estimates presented in these studies have been generated according to the methodology used by NHTSA since the first such report was produced in 1975. In developing cost estimates for proposed and existing safety standards, the objective of these studies is to derive three numbers: the direct cost to the manufacturer, the wholesale markup to dealer cost, and the dealer markup to the equivalent retail price to the car buyer. These studies are invaluable because detailed cost information of this type for airbags tends to be proprietary and exceedingly difficult to acquire. The uniformity in assumptions and methodology also make possible a direct comparison of the cost estimates, and keeps the internal validity of the reports intact.

Auto Industry Cost Factors:

1. *Material Costs:* Determined from the contemporary market price for a material.
2. *Variable Burden Rates:* Vary w/ the volume of production. For example: Setting-up the machinery, the handling of material, the cost of shipping.
3. *Corporate Overhead Expenses:* Do not vary with the volume of production. For example: 1. Depreciation 2. Amortization 3. Plant maintenance 4. Taxes other than income tax.
4. *Consumer Cost:* Obtained by using the estimated direct cost, adding the variable burden, factoring in the overhead, and determining the mark-up from dealer to customer. (Incentives are ignored in this study).
5. *Variable Cost x 1.*33 = Wholesale (Dealer) Cost
6. *MSRP = Variable cost x 1.*51

The cost-pricing formula used in NHTSA regulatory cost estimation:

- Allows all estimating to be done on a consistent basis
- Using variable cost as the starting point and predetermined mark-up rates
- Is based on real world, cost behavior patterns
- Is relatively simple to use

Markup Factors

- Manufacturer to wholesale 1.33
- Wholesaler to dealer (domestic and imported) 1.14

Variable cost development:

- For Operations:

  - Direct Labor Cost = DL*60/(pieces)*(# men) where DL = direct labor rate for one year

- Variable Burden Cost = VB/(places)*(# mach) where VB = variable burden rate for one year
- Manufacturing Burden Cost = MFG/(pieces)*(# men) where MFG = manufacturing burden rate for one year

- For materials:

  - Direct Material Cost = ((rough wt * DM) + other * (year discount))*(1+scrap %) where DM = material cost for one year

- For total costs:

  - In-house Variable Cost = (DM+DL+VB) * (# required)
  - Out of house Variable Cost = ((DM+DL+MFG)*(# required)

- For Dealer, Other and Consumer Costs:

  - VMFG = (DM+DL+VB)*(scale factor)
  - Other Profit = ((VMFG) * (vc / wc factor)) – VMFG
  - Dealer Markup = (dealer discount %) * (VMFG + other) / (1- dealer discount %)
  - Consumer Cost = VMFG + other + dealer markup

The objective of the three studies was to "determine the cost of occupant restraint systems at annual volumes, manufactured and marketed according to typical North American automotive practices." The following assumptions were made to accomplish this objective.

1. The passive restraint systems analyzed in the study are obtained complete and ready to install, from a supplier located in the U.S. The components that are not produced in-house by the OEMs are received through a captive supplier of the automobile manufacturer.
2. In-house items include knee bolsters and all brackets, reinforcements, tapping plates, etc… Structural modifications to the car body in order to accommodate the added hardware are also made in-house. The costs of such modifications were determined by comparing the cost of each piece with the cost of that piece if it were configured for the baseline system.
3. Annual production volumes are assumed to between 250,000 and 350,000 units hence manufacturing processes appropriate to these high volumes were incorporated into the analysis. Volumes for subcomponents, which may be much higher, are estimated based on consultation with experts in the representative supplier industries.
4. In the case of dual airbags, tooling costs are assigned entirely to the driver airbag cost. Components for driver and passenger airbags are assumed to be the same except where noted.
5. Final costs include installation of the airbag systems in the vehicles.

6. For the first two studies it was assumed that when the entire new passenger-car fleet becomes equipped with airbags, the costs will likely be lower.

Review of Airbag Cost Estimates (1969-1992)

What follows is a brief historical review of airbag cost estimates reported in media and government sources during and after the period of time that airbags were considered as a possible alternative to meeting the passive restraint requirement.

1969
Ford engineers stated the company would introduce an airbag on the front-seat passenger side of the 1971 Mercury Marquis, a $4,500 car. According to the engineers, the device would add about $100 to the cost of car, and would be extended to other models if successful.[3]

1970
It was reported that Ford President Iacocca believes airbag safety devices could cost $200 per car.[4] In a memorandum to Peter Flanigan, White House Aide George Crawford writes, "with regard to passive restraints, DOT says airbags for 1973 would cost $100 [per car], for 1975 $150-$200."[5]

1973
Ford Motor Co. and General Motors both offered cost estimates during Senate hearings on "Air Bag Development and Technology." General Motors stated that the retail price of the airbag option the company planned to offer on its 1974 models was in the area of $200 with an additional $25 for front lap belts. GM also told the Committee members that the cost of developing the airbag system was $35 million to date, with a substantial amount of work left to do.[6] GM continued by stating that to make airbags standard on all of its cars would require "expenditures for facilities and tools in the area of $200 million." Meanwhile, Ford declared that a front seat airbag system would have a suggested retail price without a markup for company profit of about $215.[7]

1975
It was reported in the press that the Council on Wage & Price Stability may recommend against the installation of airbags on MY 1977 cars due to the $200 extra cost.[8] NHTSA head James Gregory was quoted as saying airbags would raise prices only about $106 per car.[9] Ford Motor Co. official William F. Browne, in response, warned that costs would be closer to $300 per car. Joan Claybrook, in the same article, said the $300 figure quoted by Ford was a result of "mere analysis," and advised NHTSA to use its power to subpoena cost and production data from automakers when they oppose safety measures on economic grounds.

1976
The new NHTSA head, William Coleman, predicted a car with passive restraints would cost $80 more than one with seat and shoulder belts, well below industry estimates of

$187 to $235.[10] It was unclear what quantities of airbags and automatic seatbelts Coleman was assuming in his optimistic cost estimate.

1977

At the beginning of 1977, DOT estimated that if all cars sold in the U.S. were equipped with airbags, the price per system would be $100. From this estimate, DOT determined that the price for the dual airbag GM system would be $100 and the Ford driver-side airbag, $50, unless the General Accounting Office or an independent accounting firm selected by DOT could determine that the cost should be greater.[11] Former GM President Edward Cole refuted the DOT's cost estimate in an interview in early March of that year. He stated that any estimate under $150 was unrealistic.[12] This was an important statement for the following reasons: 1) As former GM chief he helped pioneer airbag development and was as close as anybody to the technology and its cost implications; 2) He was a staunch proponent of airbags and wanted them in every car; and 3) He was retired and no longer formerly affiliated with the auto industry, which implied a greater candor in his statements than when he had been employed by the company. Secretary of Transportation Brock Adams dodged the issue somewhat when he stated that airbags would cost $100-$300. He said during the announcement on June 30th that all new automobiles sold in the U.S. by the 1984 model year must be equipped with either airbags or passive seat belts.[13] In August, Allstate Insurance Co. ran an ad to in part to rebut a *Wall Street Journal* editorial where airbags were negatively portrayed. The ad argued that airbags would increase the auto price by no more than $111.[14] An October 13 article in *The Washington Post* cited an airbag cost of $200 and a replacement cost of $600.[15] General Motors insisted that it could not produce airbags for "much less than" the $315 the company had charged between 1973 and 1975 for the systems when they were offered as options on some Buicks, Cadillacs, and Oldsmobiles. The demonstration plan set forth by the DOT in somewhat limited cooperation with automakers demanded the cost be under $100.[16]

1978

The Wall Street Journal wrote in June that the DOT had declared that Government requirements to increase the safety, fuel economy and damage resistance of automobiles would add about $285 to the price of a passenger car by 1984.[17] According to the DOT, the $285 figure represented the approximate expense automakers would incur by installing airbags or passive seat belts to new cars, following Federal rules for improved fuel economy, and adhering to Government standards for bumpers that would be less susceptible to damage in low-speed crashes. Interestingly, automaker estimates for airbags alone were often greater than $285 at the time.

1979

A 1979 report conducted by the General Accounting Office (GAO) attempted to provide an objective analysis of, among other things, the cost of airbags in varying production volumes. GAO considered separate cost estimates by Ford Motor Co., General Motors, and the National Highway Traffic Safety Administration (NHTSA). GAO reported that the incremental cost to the consumer for comparable airbag systems was $235 according

to Ford, $193 for GM, and $112 for NHTSA.[18] The significant difference in cost estimates was due to the following methodological considerations, according to GAO:

1. Ford and GM included more sophisticated sensor and diagnostic systems than NHTSA, which analyzed an airbag system that would meet the minimum performance requirements of the agency's proposed standard.
2. A much higher dealer mark-up was used by industry to determine the final price to the consumer.
3. Ford included an overhead component to its cost estimate to account for indirect labor cost, taxes, insurance, general engineering support, purchasing, inventory control, etc…
4. GM included a commercial expenses component that estimated costs incurred from distribution, warehousing, product liability, service training, normal engineering, etc…

The study warns that, "too many uncertainties surround the introduction of air bag systems by 1981 to allow a high degree of confidence in these estimates." The above projections were also based on high volume production where the majority of an automaker's cars would be equipped with an airbag. The strategy of automakers to meet the pending regulation was to go primarily with the other, less expensive passive restraint option, the automatic safety belt. At production volumes that the industry considered to be more realistic, GM estimated a cost per system in 1979$ of $581 for the 1982 model year based on 400,000 units, and $509 for 1983 based on 750,000 units. Similarly, in July 1979, Ford estimated a cost per system in 1982$ of $828 at a production volume of 200,000 and $575 at 787,000 units. These numbers were not substantiated by a third-party source.

In a confidential memo, the Chrysler chief engineer provided estimates to A.C. Malliaris of NHTSA, that an airbag module would cost $491 at a volume of 6,000 units and $240 at 190,000 units (using an "estimated piece cost penalty based on vendor air bag module quotes.").[19] These cost estimates did not include amortization of tooling, pre-production and launch costs, engineering, research, and development, assembly cost, shipping cost, provision for liability, provision for warranty, and other contingencies.

1981

Ralph Rockow, chairman of the Automotive Occupant Protection Association, a trade group of airbag manufacturers, stated in front of a House subcommittee on consumer protection that he expected airbags produced in high volume to cost consumers a maximum of $250 to $300.[20] This was partly in response to the airbag cost alleged by GM of $1100 due to the relatively small demand that exists for the safety device. The press during the time stated that auto industry officials expected the airbag to add $500 to $800 to the price of such a vehicle.[21] Other press reports stated that airbags would cost between $100 and $200, but presumably this was not the cost to the consumer.[22] This wild variation in cost reporting reveals a major recurring problem with how airbag costs were reported. A dollar figure was usually thrown out without explanation to whether the cost represented the manufactured unit, an installed unit, or a complete airbag system as it

is priced to the consumer. Production volumes, which heavily impact any cost estimate, are often not included either.

Clarence Ditlow, the head of the Center for Auto Safety, released the contents of an internal NHTSA memo that the Center had acquired, despite the contention by NHTSA that the documents contained "proprietary financial information" protected by the Trade Secrets Act. The document, dated July 11, 1979, contained an attachment that showed Ford Motor Co. estimated in 1978 that if it equipped 885,000 of its 1982 models with airbags, the cost to the company would be $101 per vehicle.[23] Another attachment listed the GM cost estimate of $96 if airbags were installed on 3.5 million of the company's 1980 model cars. The cost to the consumer was estimated to be $206. The data in these attachments are reproduced in Table 3-2. A.C. Malliaris, the Director of the Office of Vehicle Safety Standards at NHTSA and the writer of the memo, recommended that the attached cost information and related materials should be declassified and made fit for public consumption. Furthermore, Malliaris avowed that "serious thought" should be given to designing a NHTSA Order requesting the manufacturers to produce all relevant material outlining their cost estimates and their decisions based on those assessments.

Professor William Nordhaus testified to Congress that a rescission of the passive restraint standard would have enormous societal costs attached to it. The costs of a rescission were estimated to have 3½ times the benefits. Nordhaus assumed high production and used an estimate of $400 for the cost of an airbag with an additional $25 lifetime fuel penalty.[24]

1982

The General Services Administration, through subsidies from NHTSA, contracted with Ford to purchase roughly 5,000 airbag-equipped cars for the federal fleet. It was reported that the cost would be between $300 and $500, but the cost could possibly be lower if the volume were large enough.[25]

1983

Raymond Peck, head of NHTSA, said the cost of putting airbags into federal cars in an attempt to stimulate a market for the safety devices could run as high as $500 per vehicle.[26]

1989

While airbag sales were starting to increase, the cost of a fully installed driver-side airbag was still reported to be greater than $500.[27] The cost was predicted to be falling due to the nature of governmental regulation leading to technological advances and per unit cost-drops due to mass production. Analyst Thomas O'Grady of Integrated Automotive Resources estimated that airbags would raise the price of cars between $300 and $400.[28] Robert Stempel, President of GM, warned that each airbag the company installed would cost over $500. Meanwhile, Ford spokesman Bill Carroll estimated that a driver airbag would add between $350 and $700 to the final price of each new 1990 model.[29]

1990

In Japan, Nissan announced its plan to offer at least optional airbags on all of its models by the 1992 model year. The airbags were expected to cost from 100,000 Yen (~$630) to 150,000 Yen (~$950).[30]

1991

The cost of airbags was reported to have fallen dramatically during the previous two years. According to the primary automotive trade magazine *Automotive News*, an airbag system had until recently cost between $500 and $1000, but that now a basic driver-side airbag including manual lap belts costs up to $175 depending on the vehicle model and manufacturer.[31] An additional passenger-side airbag was reported to add about $270 more. The more complex airbag systems used primarily by European automakers cost up to $600 for the driver-side and an additional $250 for the passenger-side. The article cited safety engineers who maintained that prices were falling rapidly as suppliers streamlined production methods, technology improved, and volume increased. The cost of a driver airbag from the supplier to the automaker was estimated to be between $175 and $200, but factoring in the additional costs of R & D, engineering, tooling, facilities, assembly labor, liability reserves, taxes and overhead, the true cost to the manufacturer is closer to $450 to $500.[32] The reports from Canada also confirmed this rapid decline in airbag costs. It was reported that the price of airbags had come down in only two years from between $900 and $1,200 Canadian per unit to between $300 and $350.[33]

1992-present

The *Financial Times* (of London) reported that competition played a central role in reducing airbag costs.[34] It indicated that the cost of an installed air bag fell from more than $ 1,200 to approximately $ 100 in less than five years because of aggressive cost reductions by air bag suppliers and new assembly methods introduced by car manufacturers.

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