AUTOMOBILE AIR BAGS IN THE 1990S: MARKET FAILURE OR MARKET EFFICIENCY?*

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ABSTRACT

This article seeks to explain the recent growth in the adoption of air bags in new automobiles. Our analysis focuses on market forces, that is, consumers' willingness to pay for air bags and automakers' responsiveness to consumers' willingness to pay. We find that air bags were offered by automakers because consumers were willing to pay for them—increasingly willing as information about actual experiences with air bags spread through the media and friends. Thus, in general, the market for air bags worked efficiently. Doubt has again been placed on the potential social value of automobile safety regulation and the efficacy of nonexperimental safety information campaigns.

INTRODUCTION

In 1972 Allstate Insurance was convinced that air bags could save lives—so convinced that it began equipping its company cars with air bags and offering discounts to customers who owned cars with air bags. Today, most people would agree that Allstate was right: air bags can save lives. But as recently as 1983, Mercedes Benz, alone among automobile manufacturers, was offering driver-side air bags in the United States, and, as shown in Figure 1, as late as 1988 only 2 percent of new cars were equipped with this safety feature. Then something happened. Since 1988 growth in air bag installation has been dramatic. Projections are that 90 percent of all 1996 models will have air bags.

One can debate how much control the automakers have had over the air bag's destiny.[1] Because of the air bag's substantial expense, however, what is not debatable is that, in the absence of regulation, consumers

* We acknowledge helpful comments from John Calfee, Robert Crandall, Steven Morrison, Sam Peltzman, Kenneth Small, and a referee.

[1] Beginning in 1998, automakers will be required by government regulators to install air bags in their vehicles. It could be argued that automakers perceived a threat that air bags would be required by regulation and so moved ahead to meet that requirement. This seems unlikely because such requirements have been postponed in the past. Similarly, penalties for failing to meet corporate average fuel economy requirements have been repeatedly postponed.

[*Journal of Law and Economics*, vol. XXXVIII (October 1995)
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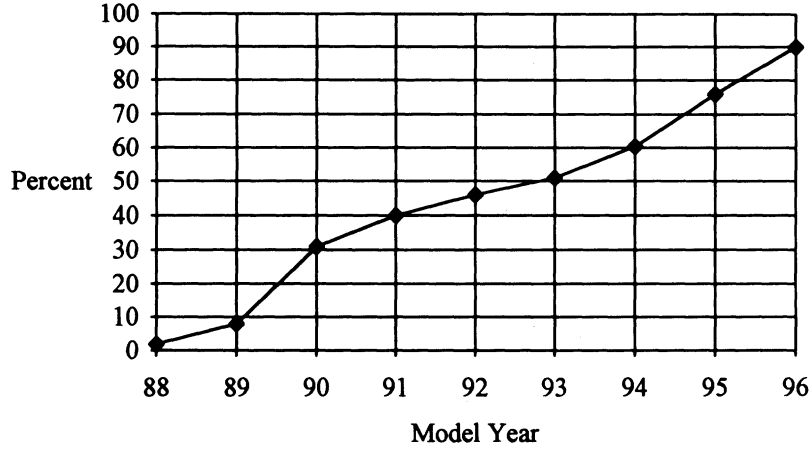

FIGURE 1.—Air bag growth: percentage of model year cars with air bags (totals are projected for 1992–1996 model year cars). Source: Insurance Institute.

must be willing to pay the marginal cost of air bag installation if these devices are to become and remain a standard automobile safety feature. Using a model to estimate consumers' willingness to pay for air bags, we find that consumers are willing now to pay the marginal cost of air bag installation. Thus, the recent widespread adoption of air bags and the eventual elevation of them to be a standard feature in all vehicles seems to be the product of an efficient market.

CONSUMERS' WILLINGNESS TO PAY FOR AIR BAGS

Until air bags became widely available, estimates of their benefits were necessarily based on engineering simulations of the reduction in the probability of death from an automobile accident attributable to air bags and on economists' estimates of the value of life.[2] That is, previous estimates reflected what consumers *should* be willing to pay for air bags.

But since 1990 air bags have been available on enough vehicle models to permit us to infer through a statistical model what consumers *are*

[2] See, for example, Richard J. Arnould & Henry Grabowski, Auto Safety Regulation: An Analysis of Market Failure, 12 Bell J. Econ. 27 (1981); John Graham, Max Henrion, & M. Granger Morgan, An Analysis of Federal Policy toward Automobile Safety Belts and Air Bags (working paper, Carnegie-Mellon Univ., Dep't Eng'g & Pub. Pol'y 1981); Clifford Winston & Fred Mannering, Consumer Demand for Automobile Safety, 74 Am. Econ. Rev. 316 (May 1984).

willing to pay for air bags.[3] The approach we take is to estimate a model of consumer choice of which new vehicle to purchase. The coefficients that capture the effect, on this choice, of a vehicle's price and whether an air bag is available on this vehicle can be used to estimate consumers' willingness to pay for an air bag.

Consumers' new vehicle choice preferences are given by the multinomial logit model, which is commonly used when one wishes to estimate the parameters of possible influences on a discrete choice such as the choice of automobile. The multinomial logit vehicle choice probabilities are given by

$$\text{prob}_i = \exp(V_i) \Big/ \sum_{j=1}^{J} \exp(V_j)$$

where V_i denotes the indirect utility from vehicle alternative i, and J is the set of vehicle alternatives including vehicle i. We specify the indirect utility consumers derive from their vehicle choice as a function of vehicle attributes (including purchase price and the availability of an air bag), their socioeconomic characteristics, and their brand loyalty and brand preference.[4] This leads to estimating the relation:

$$\text{prob}_i = f(\text{attributes}_j, \text{socioeconomic characteristics}, \text{brand loyalty}_i, \text{brand preference}_j, j = 1, \ldots, J).$$

Consumers' valuation of air bags will depend on the extent to which they are aware of and believe any claims about an air bag's potential to save lives in a crash. Consumers are likely to learn about air bags from advertisements and news stories on television, reading newspapers and automotive magazines, speaking with friends who own cars with an air bag, and reflecting on their vehicle accident history. We therefore include the availability of an air bag in a particular model as a vehicle attribute but interact it with various "information" variables to capture consumers' potential exposure to the effectiveness of air bags. The other vehicle attributes included in the specification are vehicle price, weight, size,

[3] John E. Calfee & Clifford Winston, The Consumer Welfare Effects of Liability for Pain and Suffering: An Exploratory Analysis, Brookings Papers Econ. Activity: Microecon., 1993, No. 1, at 133, find consumers' willingness to pay for prevention devices incorporates accurate estimates of the risks associated with low probability events such as an automobile accident.

[4] This specification draws on and extends our previous work (see Fred Mannering & Clifford Winston, A Dynamic Empirical Analysis of Household Vehicle Ownership and Utilization, 16 RAND J. Econ. 215 (1985), and Brand Loyalty and the Decline of American Automobile Firms, Brookings Papers Econ. Activity: Microecon., 1991, at 67).

seating capacity, horsepower, and a repair index.[5] Socioeconomic variables include the consumers' age, household income, residential location, and number of vehicles owned.

As in our previous work, we draw a distinction between brand loyalty and brand preference. Brand loyalty captures the consumer's accumulated information about a brand. It is specified as the number of previous consecutive purchases of the same brand of vehicle as the new vehicle purchase. Brand preference captures the tendency for consumers to purchase a specific brand of vehicle all else being equal. It is specified by vehicle make dummy variables.

The data set is from a national household panel administered by National Family Opinion, Inc., Toledo, Ohio, and managed by Alison-Fisher, Inc. The sample consisted of complete vehicle ownership histories of households that purchased a new car during 1990–93. Respondents provided information to construct the brand loyalty variables, socioeconomic variables, and air bag interaction variables (for example, air bag availability and number of hours of daily television viewing). The remaining vehicle attributes are from the 1990–93 issues of the *Market Data Book* published by Automotive News. Separate new vehicle choice models were initially estimated for the years 1990, 1991, 1992, and 1993. Because statistical tests indicated that the models' parameters were not statistically significantly different during these time periods, we estimated a single model for the entire period.[6] Estimation results are presented in Table 1.

[5] We included fuel efficiency in the initial specification, but it was found to be statistically insignificant. This is not surprising given our sample period.

[6] The choice alternatives were thus new cars defined by make, model, and vintage. As in our previous automobile choice models, the logit (independence from irrelevant alternatives) specification was statistically tested and not rejected, the parameters obtained from instrumented brand loyalty variables were very similar to the parameters obtained from uninstrumented variables (thus, the uninstrumented variables were used in the final estimation), and estimation was achieved by random subsampling of 10 alternative vehicles (including the chosen alternative). Finally, the estimation results were not affected by including consumers who made more than one new car purchase during our sample period (that is, the potential bias created by the correlation of the error terms of a consumer with multiple observations was negligible).

An alternative choice structure would explicitly include the choice to buy an air bag–equipped vehicle. This choice would be influenced by socioeconomic characteristics, information variables, and the attributes of vehicles with and without air bags. This leads to a nested logit model, with the upper level being the choice of whether to buy a car with a driver-side air bag and the lower levels being the choice of vehicle type conditioned on the air bag choice. We estimated such a model but statistically rejected the nested logit structure because the log sum coefficient was not statistically significantly different from one. (We were less than 5 percent confident that the log sum coefficient was not equal to one.) This implies that it is appropriate to use a nonnested structure and to estimate directly a vehicle choice model.

TABLE 1

MULTINOMIAL LOGIT COEFFICIENT ESTIMATES FOR 1990, 1991, 1992, AND 1993: NEW-VEHICLE CHOICE

Variable	Coefficient
Vehicle attributes:	
Number of friends owning cars with air bags (defined only for car models with driver-side air bags)	.382
	(.105)
Average number of hours spent watching television per day (defined only for car models with driver-side air bags)	.069
	(.026)
Average number of hours spent watching television per day (defined only for car models with antilock brakes)	.0596
	(.022)
Vehicle weight (in pounds) per seating capacity (defined for all car models)	.00561
	(.001)
Vehicle weight (in pounds) (defined for all car models)	.000853
	(.000277)
Vehicle seating capacity (defined for all car models)	.446
	(.167)
Vehicle horsepower* (defined for all car models but only for households with two or more vehicles)	.00675
	(.0021)
Consumer Report's repair index† (defined for all car models)	.232
	(.057)
Natural log of vehicle price (in thousands of dollars) divided by consumer's household annual income (in thousands of dollars)‡ (defined for all car models)	−378.4
	(15.05)
Subcompact/compact class dummy (defined for all car models; = 1 if vehicle is a subcompact or compact and the consumer's household has 2 or more vehicles and = 0 otherwise)	.637
	(.187)
Intermediate class dummy (defined for all car models; = 1 if vehicle is an intermediate and = 0 otherwise)	1.749
	(.143)
Luxury and near-luxury class dummy§ (defined for all car models; = 1 if vehicle is in the luxury or near-luxury class and = 0 otherwise)	3.91
	(.257)
Socioeconomics:	
Consumer's age (in years) (defined only for GM, Ford, and Chrysler products)	.0223
	(.00565)
Consumer's annual household income (in thousands of dollars) (defined only for GM, Ford, and Chrysler products)	−.0029
	(.0022)
Metropolitan area dummy (defined only for Nissan, Honda, and Toyota products; = 1 if consumer resides in a metropolitan area with a population greater than 2,000,000 and = 0 otherwise)	.237
	(.181)

TABLE 1 (*Continued*)

Variable	Coefficient
Number of children (less than 16 years of age) in the household (defined only for minivans)	.781
	(.152)
Brand loyalty and preference:	
Number of previous consecutive GM purchases (defined only for GM products)	.773
	(.092)
Number of previous consecutive Ford purchases (defined only for Ford products)	1.272
	(.134)
Number of previous consecutive Chrysler purchases (defined only for Chrysler products)	.841
	(.176)
Number of previous consecutive Japanese manufacturer purchases (defined only for Acura, Honda, Nissan, Infiniti, Toyota, Lexus, Mazda, and other Japanese products)	1.861
	(.247)
American manufacturer dummy (defined only for GM, Ford, and Chrysler products; = 1 if GM, Ford, or Chrysler product and = 0 otherwise)	−1.456
	(.345)
Summary statistics	
Number of observations	1,419
Estimation by maximum likelihood:	
Log likelihood at zero	−2,283.8
Log likelihood at convergence	−1,429.1

NOTE.—Standard errors are in parentheses.

* Horsepower was found to be significant only for multivehicle households. This probably reflects vehicle specialization in such households, which eliminates "compromise" purchases and allows consumers to respond more freely to particular vehicle attributes such as horsepower.

† *Consumer Report*'s repair index is a measure of reliability that is scaled from 1 to 5. A value of 1 indicates the vehicle has a "much below average" repair record (that is, an unreliable repair record), 3 is "average," and 5 is a "much better than average" repair record.

‡ The natural log of vehicle price provided a much better statistical fit than the nontransformed vehicle price. This specification implies that an incremental increase in the price of a vehicle has less of an effect on the demand for expensive vehicles than on the demand for inexpensive vehicles. For example, a $1,000 price increase will have a much smaller impact on an $80,000 vehicle's selection probability than on a $9,000 vehicle's selection probability. The division of the natural log of price by income incorporates the notion that price sensitivity is inversely related to income.

§ The near-luxury class includes vehicles such as the Buick Electra, Oldsmobile Ninety-Eight, Volvo 700 series, BMW 3 series, Lexus ES250/300, and Mazda 929.

The air bag coefficients are especially important to our analysis. The estimates indicate that the availability of an air bag interacted with either of two potential information sources about air bag effectiveness (hours of daily television viewing and number of friends owning cars with air bags) has a positive statistically significant effect on vehicle choice.[7]

[7] The availability of an air bag without the information interaction variables also had a positive statistically significant effect on vehicle choice, but this specification had a lower log likelihood at convergence than the specification with the information interaction variables.

Friends provide opportunities for demonstration effects, while television viewing provides opportunities to obtain hard evidence of air bag effectiveness through automakers' advertisements and occasional news stories that feature people who actually survived serious automobile crashes because of air bags.[8] Antilock brakes, another new safety feature, also had a positive statistically significant effect on vehicle choice. With the exception of vehicle price, which has a negative effect, the other vehicle attributes have a positive statistically significant effect on vehicle choice. The socioeconomic variables identify particular market segments that have a preference for or against American manufacturers. Finally, the brand loyalty coefficients indicate that American consumers continue to have stronger loyalty toward Japanese than toward American cars.[9] This suggests that the American manufacturers' recent gain in market share does not signify an erosion in Japanese loyalty; rather, it reflects the effect of sharply rising Japanese car prices caused by an appreciation of the yen and fears of protectionist legislation. This conclusion is underscored by our finding of brand preference for Japanese cars during the 1990s, which reverses previous findings of brand preference for American cars during the 1980s.[10]

The coefficient estimates can be used to calculate consumers' average willingness to pay (WTP) for air bags. Figure 2 shows estimates of the average WTP for a driver-side air bag, arrived at by forming the ratio of the air bag coefficients and the vehicle price coefficient and enumerating through the household sample.[11] Because we are estimating an indirect

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We investigated two potential specification problems with the interaction variables. Because people who have decided to buy cars with air bags may have listed (or be aware of) more friends who own cars with air bags in order to justify their purchase, the "friends" variable may be endogenous. We therefore instrumented the number-of-friends variable but found no noticeable change in the air bag–friends coefficient, which suggests that the friends variable is not being systematically overreported. We also tested for the possibility that the effect of hours of daily television viewing is nonlinear (that is, the marginal impact of an hour of television watched could decrease as total viewing hours increase), but we found that the linear specification provided the best statistical fit.

[8] We investigated other potential air bag information sources and found them to be statistically insignificant. These sources include the number of automotive magazine subscriptions, number of newspapers regularly read, education, an American Automobile Association membership, an insurance company offer of a discount for air bag–equipped vehicles, and vehicle accident histories (including whether air bags were activated).

[9] Mannering & Winston, Brand Loyalty, *supra* note 4, at 79, found that American consumers had stronger loyalty toward Japanese cars than toward American cars during the 1980s.

[10] *Id.* at 79, 81. This reversal could be due to Japanese transplants increasing the share of Japanese vehicles that are built in America, thus eroding the U.S. automakers' "buy American" advantage.

[11] Because the price variable enters as the natural log of price divided by income, the

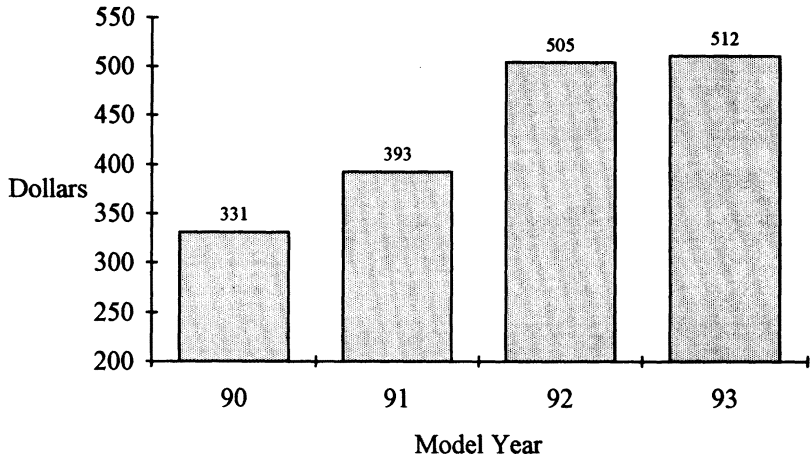

FIGURE 2.—Average willingness to pay for driver-side air bags, by model year

utility function, this calculation effectively asks: given the availability of an air bag on a vehicle, which provides positive utility, how much money would have to be added to the price of the vehicle, which will provide negative utility, to keep the individual's level of utility from their vehicle choice constant? The average WTP, $331 in 1990, appears to have stabilized at slightly more than $500 in 1993.[12] The increase primarily reflects the greater knowledge that people have about air bags from their friends who own cars equipped with them. These magnitudes are plausible because they imply a value of life of some $3 million.[13]

effective vehicle price coefficient used to calculate WTP will change depending on the value of the vehicle and household income. Thus, we must enumerate through households and vehicles to obtain an average WTP. We could not estimate the average WTP for dual (driver and passenger) air bags because they were not available on enough vehicles. It is also possible that WTP could be a function of whether driver-side air bags are offered as standard or optional equipment. To test this possibility, we estimated separate coefficients for those vehicles that have air bags as optional equipment and those that have air bags as standard equipment. Likelihood ratio tests indicated that these coefficients were not statistically significantly different, and thus WTP did not vary between standard and optionally equipped vehicles. It is also possible that the WTP estimates partly capture preferences for restyled models that often include air bags for the first time. Likelihood ratio tests indicated, however, that the air bag coefficients for redesigned vehicles and for vehicles with essentially unchanged designs were not statistically significantly different.

[12] Our WTP estimates should be statistically reliable because they are derived from coefficients that are highly statistically significant.

[13] The value-of-life estimate is obtained as follows. In 1992, roughly 36 percent (or 14,220) of the 39,500 fatalities on U.S. highways were drivers. Leonard Evans, Restraint Effectiveness, Occupant Ejection from Cars, and Fatality Reductions, 22 Accident Analysis & Pre-

The WTP estimates are based on the specification of vehicle choice that we found to have the greatest statistical justification—simpler specifications that did not include the air bag interaction variables were subject to a specification error (that is, omitted variables bias); including additional interaction variables or using alternative functional specifications did not improve the model's statistical fit. Nonetheless, it appears that the WTP estimates are robust to alternative specifications of the choice model. For example, when we alternately omitted key variables, such as vehicle weight and brand loyalty, and various socioeconomic variables, the average WTP did not vary by more than 12 percent in any of the four model years (that is, the largest change occurred in 1990 when average WTP changed from $331 (our base case) to $367.) Similarly, the inclusion of irrelevant variables (that is, variables whose coefficients did not exceed their standard error), such as length of wheelbase, number of engine cylinders, and number of automotive magazines consumers regularly read, produced virtually no change in WTP.

Table 2 presents the willingness to pay for air bags for selected models. As allowed for by our specification, consumers are willing to pay considerably more for air bags when they are available on luxury cars, such as a Mercedes, Cadillac, or Lincoln, than when they are available on economy cars, such as a Ford Escort or a Chevrolet Cavalier.[14] This partly explains why auto manufacturers have tended to follow the strategy of first making air bags standard equipment on their full-size and luxury cars before making them standard equipment on their compact cars.[15] The table also suggests that the air bag market appears to respond to consumers' preferences. When consumers' WTP for an air bag on a particular

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vention 167 (1990), estimates for all collision types that air bags reduce the likelihood of a fatality by 18 percent. Given approximately 170 million U.S. drivers, the annual probability of a driver fatality is 0.00008365, which a driver-side air bag would reduce by 0.000015057 (0.00008365 × 0.18). Assuming a vehicle life of 10 years (and ignoring discounting which gives us a lower bound), our 1992 WTP for air bags estimate comes to $50.50 per year, which implies a value of life of $3,353,921 ($50.50 ÷ 0.000015057). The National Safety Council, *Estimating the Cost of Accidents, 1992* (1992), estimates the value of life based on a highway fatality to be $3,040,000.

[14] Recall that our specification of vehicle price as the natural log of price divided by income implies that the WTP will be affected by vehicle price and household income.

[15] We investigated whether the value of air bag availability varied by manufacturer, for example, because of advertising. We found that the air bag coefficients were not statistically significantly different across manufacturers. (We were less than 10 percent confident that a difference existed.) Separate air bag coefficients were also estimated for different sizes of cars (for example, subcompacts, compacts, and intermediates). Again, these coefficients were not significantly different. (We were less than 20 percent confident that a difference existed.)

TABLE 2

AVERAGE WILLINGNESS TO PAY FOR DRIVER-SIDE AIR BAGS BY MODEL YEAR AND MODEL (for Select Models, in Dollars)

	1993		1992		1991		1990	
MAKE AND MODEL	Driver-Side Air Bag	Willingness to Pay (Average = $512)	Driver-Side Air Bag	Willingness to Pay (Average = $505)	Driver-Side Air Bag	Willingness to Pay (Average = $393)	Driver-Side Air Bag	Willingness to Pay (Average = $331)
Acura Legend	Standard	639	Standard	630	Standard	482	Standard	405
Buick Skylark	Not available	421	Not available	415	Not available	317	Not available	267
Cadillac Deville	Standard	717	Standard	707	Standard	541	Standard	454
Chevrolet Caprice	Standard	490	Standard	483	Standard	370	$600 option	311
Chevrolet Cavalier	Not available	348	Not available	344	Not available	263	Not available	221
Chrysler LeBaron	Standard	432	Standard	423	Standard	330	Standard	280
Ford Escort	Not available	330	Not available	325	Not available	249	Not available	209
Ford Taurus	Standard	438	Standard	432	Standard	331	Standard	278
Honda Accord	Standard	468	Standard	461	$600 option	353	Not available	292
Lincoln Continental	Standard	702	Standard	692	Standard	529	Standard	445
Mercedes 300 series	Standard	972	Standard	958	Standard	733	Standard	616
Toyota Camry	Standard	456	Standard	449	Not available	344	Not available	289

NOTE.—Willingness to pay is obtained using the ratio of air bag coefficients (number of friends and number of hours watching television; see Table 1) to the vehicle price coefficient. Because the estimated price coefficient is based on a specification of price as the natural log of price divided by income, willingness to pay will vary by vehicle (as a function of its price and household incomes). Sample enumeration is thus necessary to estimate the average willingness to pay for each vehicle.

vehicle falls significantly below their average WTP, an air bag is not available for that vehicle.[16]

The relation between WTP and air bag adoption can be affirmed by a simple statistical model.[17] We define air bag adoption by a discrete dependent variable that takes on the value of one if an air bag is included as standard equipment in a model, and zero otherwise. Including all vehicle models during 1990–93, we then estimated a binary logit model of air bag adoption as a function of our estimated WTP for an air bag on a given model and model-year dummies to control for the possibility that there might be a trend toward adoption. The estimation results presented in Table 3 show that willingness to pay for an air bag on a particular vehicle model has a positive statistically significant effect on the probability that an air bag will be offered as standard equipment. All of the year dummies are statistically insignificant, indicating that there is no underlying trend toward adoption, just an increase in willingness to pay.[18] The average WTP elasticity is estimated to be 1.89, which indicates that a 1 percent increase in WTP will produce a 1.89 percent increase in the probability that a driver-side air bag will be offered as standard equipment.[19] This implies that automobile manufacturers have, in fact, been very responsive to changes in consumers' willingness to pay for air bags and contradicts the belief held in some circles that the industry has generally been reluctant to adopt air bags.

Air Bags and Automakers' Profitability

Estimates of the marginal cost of driver-side air bags cluster around $250 (see Table 4). Including a typical dealer markup of 20 percent would raise the marginal cost of an air bag to roughly $300.[20] Given our estimates of consumers' willingness to pay and even allowing for the possibility that

[16] As we report below, a below-average WTP is also usually below the marginal cost of air bag installation.

[17] We are grateful to Sam Peltzman for first providing this demonstration.

[18] The coefficient for WTP and its statistical significance were not affected if the model-year dummies were eliminated from the specification.

[19] The average elasticity is obtained by calculating through sample enumeration the following elasticity formula and taking the sample average: $(1 - \text{prob}_{si}) \times \beta_1 \times \text{WTP}_i$, where prob_{si} is the probability that air bags are included as standard equipment in vehicle alternative i, β_1 is the estimated coefficient for WTP_i given in Table 3, and WTP_i is our estimated willingness to pay for an air bag on vehicle i.

[20] Because the cost estimates are based on production levels that probably exhaust scale economies, marginal and average costs coincide. Thus, our analysis of the social welfare standard (WTP $\geq$ MC) also applies to the automakers' profitability objective (WTP $\geq$ AC).

TABLE 3

BINARY LOGIT COEFFICIENT ESTIMATES FOR DETERMINING THE PROBABILITY OF AIR BAGS BEING OFFERED AS STANDARD EQUIPMENT IN 1990, 1991, 1992, AND 1993 MODEL-YEAR VEHICLES

Variable	Coefficient
Constant	−4.84
	(.560)
Average willingness to pay (in dollars)	.01267
	(.00127)
1990 model-year dummy	.359
	(.324)
1991 model-year dummy	−.0098
	(.302)
1992 model-year dummy	−.303
	(.291)
Summary statistics:	
Number of observations	566
Estimation by maximum likelihood:	
Log likelihood at zero	−392.32
Log likelihood at convergence	−274.41

NOTE.—1993 model year is normalized to zero. Standard errors are in parentheses.

TABLE 4

DRIVER-SIDE AIR BAG SYSTEM 1992–93 INCREMENTAL COSTS AND RETAIL PRICES AS AN OPTION

Source	Assumed Production Level (in Units)	Incremental Costs (in $)
Chrysler Corporation	. . .	250–300
TRW Corporation	200,000	255
Mobility Systems and Equipment Company*		
Buick Roadmaster (GM)	300,000	202
Chevrolet Camaro (GM)	300,000	182
Plymouth Acclaim (Chrysler)	300,000	142
Toyota Camry	300,000	202
	Retail Price as an Option (in $)	
Range of industry prices†	224–800	
Saturn Corporation	625	

* Data are derived from Mobility Systems and Equipment Company, Cost Estimates of Manual and Automatic Crash Protection Systems (CPS's) in Selected 1988–1992 Model Year Passenger Cars (September 22, 1992). Costs are estimated for the entire crash protection system, which includes seat belts which cost approximately $25–$35.

† Data are derived from General Accounting Office, Motor Vehicle Regulations: Regulatory Cost Estimates Could Be Improved (July 1992).

TABLE 5

SCENARIOS REGARDING 1992 PROFITS ON THE ASSUMPTION BOTH THAT DRIVER-SIDE AIR BAGS WERE DISCONTINUED AND THAT THEY ARE PRICED AT $400

	CHANGE IN MANUFACTURER PROFITS (in Millions of Dollars)					
SCENARIO	GM	Ford	Chrysler	Toyota	Honda	Nissan
All manufacturers discontinue offering air bags in all models	−12	−66	13	−26	7	−1
Each individual manufacturer discontinues offering air bags in all their models while other manufacturers offer air bags in models as observed in 1992	−749	−532	−173	−222	−175	−130

the marginal cost estimates are underestimated,[21] the recent widespread adoption of air bags is consistent with a rational market outcome.[22] Table 5 reinforces the conclusion that air bags are supported by the market by showing that the industry as a whole would lose profits if all automakers discontinued offering air bags and that each automaker would lose substantial profits if it independently decided not to offer air bags.[23]

CONCLUSION

Surprisingly, the recent widespread adoption of air bags has not revived the decades-old debate over the justification for and effects of auto-

[21] In some instances, the *price* of air bags as an option exceeds the average WTP. This does not necessarily indicate that the cost estimates are too low. In all likelihood, automakers are trying to capture surplus from some consumers especially if these consumers are able to obtain discounts from their insurance company for owning a car with an air bag.

[22] This empirical finding is not an artifact of our data. That is, if there were little variation in air bag prices and air bag market penetration were high, then the air bag coefficients would be forced to approximate their price. There was, in fact, wide variation in air bag prices during the late 1980s when they were available as an option. (This variation is difficult to observe currently because air bags are usually a standard feature, if available, so their price is included in the total vehicle price.) In addition, when air bag market penetration was moderate (that is, 30 percent in 1990), the air bag coefficients were not statistically significantly different from the air bag coefficients in later years when penetration was higher.

[23] This calculation is based on a nested logit model. The upper nest estimates the choice of whether to purchase a new vehicle (see the Appendix), and the lower nest is the vehicle choice model previously estimated. We then calculate the change in automobile demand, by vehicle model that results from the scenarios presented in the table and multiply each change by the appropriate price cost margin contained in Steven Berry, James Levinsohn, & Ariel Pakes, Automobile Prices in Market Equilibrium: Parts I and II (Working Paper No. 4264, National Bureau of Economic Research, Cambridge, Mass., 1993) to obtain changes in profitability.

mobile safety regulations. As we see it, the adoption of air bags was a rational market outcome. Air bags were offered by automakers because consumers were willing to pay for them—increasingly willing as information about actual experiences with air bags spread through the media and friends.

To be sure, people will endlessly debate whether air bags could or should have been introduced earlier. Nonetheless, because consumers needed time to learn about air bags' performance in actual accidents, automakers were right to make this feature available only gradually.[24] As such, there should be no doubt that, in general, the market for air bags worked efficiently. What *is* doubtful is the potential social value of automobile safety regulation and the efficacy of nonexperimental safety information campaigns.

APPENDIX

TABLE A1

BINARY LOGIT PARAMETER ESTIMATES FOR THE CHOICE TO BUY A NEW VEHICLE OR NOT TO BUY A NEW VEHICLE, FOR 1990, 1991, AND 1992 MODEL YEARS

Variable	Coefficient
Constant	1.575
	(1.044)
Natural log of consumer's household annual income (in thousands of dollars)	−.668
	(.240)
Average age of all vehicles currently owned by the consumer's household	.0602
	(.0095)
Number of vehicles currently owned by the consumer's household	.107
	(.043)
New vehicle choice inclusive value	.044
	(.014)
Summary statistics:	
Number of observations	4,020
Estimation by maximum likelihood:	
Log likelihood at zero	−2,786.5
Log likelihood at convergence	−2,420.3

NOTE.—All variables are defined for the buy-new alternative. Standard errors are in parentheses.

[24] Automakers continue to be interested in offering safety features that consumers are willing to pay for. Without any prodding from the government, GM and Mercedes are developing air bags for side impact crashes. But GM has cautioned that whether side bags are technologically or commercially feasible remains to be seen.

BIBLIOGRAPHY

Arnould, Richard J., and Grabowski, Henry. "Auto Safety Regulation: An Analysis of Market Failure." *Bell Journal of Economics* 12 (1981): 27–48.

Automotive News. *Market Data Book.* Detroit: Automotive News, 1990–93.

Berry, Steven; Levinsohn, James; and Pakes, Ariel. "Automobile Prices in Market Equilibrium: Part I and II." National Bureau of Economic Research Working Paper No. 4264. Cambridge, Mass.: National Bureau of Economic Research, 1993.

Calfee, John E., and Winston, Clifford. "The Consumer Welfare Effects of Liability for Pain and Suffering: An Exploratory Analysis." *Brookings Papers on Economic Activity: Microeconomics,* no. 1 (1993), pp. 133–96.

Evans, Leonard. "Restraint Effectiveness, Occupant Ejection from Cars, and Fatality Reductions." *Accident Analysis and Prevention* 22 (1990): 167–75.

Graham, John; Henrion, Max; and Morgan, M. Granger. "An Analysis of Federal Policy toward Automobile Safety Belts and Air Bags." Working paper. Pittsburgh: Carnegie-Mellon University, Department of Engineering and Public Policy, 1981.

Mannering, Fred, and Winston, Clifford. "A Dynamic Empirical Analysis of Household Vehicle Ownership and Utilization." *RAND Journal of Economics* 16 (1985): 215–36.

Mannering, Fred, and Winston, Clifford. "Brand Loyalty and the Decline of American Automobile Firms." *Brookings Papers on Economic Activity: Microeconomics* (1991), pp. 67–114.

National Safety Council. "Estimating the Cost of Accidents, 1992." Itasca, Ill.: National Safety Council, Statistics Department, 1992.

Winston, Clifford, and Mannering, Fred. "Consumer Demand for Automobile Safety." *American Economic Review* 74 (May 1984): 316–19.