HIGHWAY LOSS DATA INSTITUTE

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Predicted availability of safety features on registered vehicles

Introduction

In 2008, the Insurance Institute for Highway Safety (IIHS) estimated the potential benefits of several collision avoidance technologies. Researchers estimated that 3,435,000 unique crashes could be addressed by the assessed technologies (Farmer, 2008). A follow-up study published by IIHS in 2011 took into account the limitations of the systems and estimated that nearly 1.9 million crashes could be prevented or mitigated each year by four collision avoidance technologies (Jermakian, 2011). In 2009, the Highway Loss Data Institute (HLDI) produced the first ever evaluation of the effect of a collision avoidance technology on insurance losses. The evaluated system, Distronic, an adaptive cruise control system bundled with forward collision warning functionality, was found to reduce property damage liability claim frequencies by 8 percent and collision claim frequencies by 5 percent (HLDI, 2009). In June of 2011 HLDI studied Volvo's City Safety technology and found that it reduced property damage liability claim frequencies by 27 percent and collision claim frequencies by 22 percent when compared with other midsize luxury SUVs (HLDI, 2011).

Given the potential and proven benefits of these systems, it is almost certain that they will reduce the number of crashes and insurance claims. While estimating the efficacy of available systems is an important part of understanding the long-term impact of these systems, it is also important to understand the prevalence of these systems in the current fleet and to estimate their growth in the fleet over time. The purpose of this bulletin is to quantify the prevalence of vehicle features in the registered vehicle fleet, trace that prevalence from introduction through the most current registration data, and then to predict the prevalence in the future.

Methods

This bulletin combines vehicle feature information from the Highway Loss Data Institute with vehicle registration data from R.L. Polk and Company. For each feature studied there are three figures:

- The **first figure** illustrates the percentage of new vehicle series with a given feature by model year. In this figure each new vehicle series (model year, make, series) is a single observation. The observations have not been weighted by insurance exposure or vehicle registration information. Using new vehicle series to illustrate how common a feature is can be deceiving because new safety features typically appear initially on luxury vehicles which tend to be sold in lower volumes than non-luxury vehicles.
- The **second figure** for each feature illustrates the percentage of registered vehicles with a feature by calendar year. In this figure each observation (model year, make, series) is weighted by the number of registered vehicles.
- The **third figure** for each feature illustrates the predicted availability for that feature. The actual availability is also displayed for comparison. This figure helps to provide insight into the time required for the presence of a feature to build in the registered vehicle fleet.

The following features are included in this bulletin: antilock brakes (ABS), electronic stability control (ESC), driver frontal airbags, side airbags, and forward collision warning (FCW) systems. These features have been selected for a variety of reasons. ABS and ESC were chosen because they are interesting when contrasted with each other. Early safety research on ABS did not demonstrate a benefit for this feature and it was never required by the National Highway Traffic Safety Administration (NHTSA). By contrast ESC, which is an extension of ABS, did show early promise in safety research and was eventually required by NHTSA. Front and side airbags were included for similar reasons as they both

showed promise in reducing serious occupant injury and death. Federal requirements for driver frontal airbags were phased in over a period of several years. They were first required on some vehicles beginning on September 1, 1996. Side airbags, however, are not required by federal mandate to be installed in vehicles. Forward collision warning systems were included in the analysis because of the promising results found in the evaluation of the Mercedes Distronic system.

Vehicle feature information was obtained by HLDI. The feature information is structured by model year, make, and series. The same three variables were mapped to the registration data from R.L. Polk. For each model year-make-series combination, one of three possible feature values are provided: "standard," "optional," and "not available." Registration counts belonging to either of the first two groups are hereafter referred to as "available." For example, in calendar year 2007, 7.1 percent of registered vehicles had standard ESC and another 9.2 percent had it as an option, so it is said that ESC was available in 16.3 percent of the 2007 registered vehicles.

The most recent R.L. Polk data available to HLDI contains calendar years 1976 to 2010. For each calendar year, a number of recent model years is available, ranging from 9 model years for calendar year 1976 to 37 model years for calendar year 2010. The number of model years included in each calendar year has increased over time. For calendar years 2003 and later, 37 most recent model years were available. For calendar years 1996 to 2002 at least 30 most recent model years were in the dataset. This covered at least 95 percent of the overall fleet in calendar years where safety features started to gain popularity. There are model years that are present in earlier calendar years, age out of the dataset, and then re-enter when the dataset was expanded. To increase the amount of usable data, missing values were extrapolated based on existing values.

In order to predict the availability of features in future calendar years, the registration data was extrapolated to reflect the hypothetical fleet for each calendar year from 2011 to 2050. The extrapolation was made on the following two assumptions:

1. The number of new vehicles will stay at the same level, calculated as the average of the five most recent years available, rounded to the next million.
2. The future attrition rate of the aging vehicles will be the same as in the past.

Approach used to estimate the number of new vehicles: There were a total of 8,045,311 registered model year 2010 vehicles in calendar year 2010, 6,886,581 model year 2009 vehicles in 2009, 10,803,133 model year 2008 in 2008, 12,014,754 model year 2007 in 2007, and 11,596,942 model year 2006 in 2006. The average of those 5 numbers equals 9,869,344 and rounding to the nearest million produces a value of 10,000,000. This is the assumed value for new vehicles.

Approach used to estimate attrition rates: Attrition rates were calculated for each calendar/model year combination using the average of all available attrition rates for that age of vehicle (vehicle age = calendar year – model year). For example, the number of registrations for model year 2008 in calendar year 2011 had to be extrapolated. The vehicle age of this cell is 3. The average attrition rate from cells with a vehicle age of 3 (i.e. model year 2007 in calendar year 2010, model year 2006 in calendar year 2009, etc.) were averaged (1.46 percent). This average was applied to the last known value for model year 2008 in calendar year 2010 (13,572,642) to produce the number of model year 2008 vehicles in calendar year 2011 (13,374,396).

The estimation procedure was conducted separately for each feature in the study. The procedure involved running a logistic regression model (assuming a binomial distribution with a probit link) on the past year data where feature prevalence is known and then applying the model estimates to predict the feature prevalence for future years. For ESC and driver frontal airbags, the percentage for these features after the required model year is set to 100 percent. The dependent variable in the model was the ratio of the registration count where the feature was available to the total registration count. The only two independent variables were calendar year and model year.

Figure 1: Percentage of new vehicle series with ABS

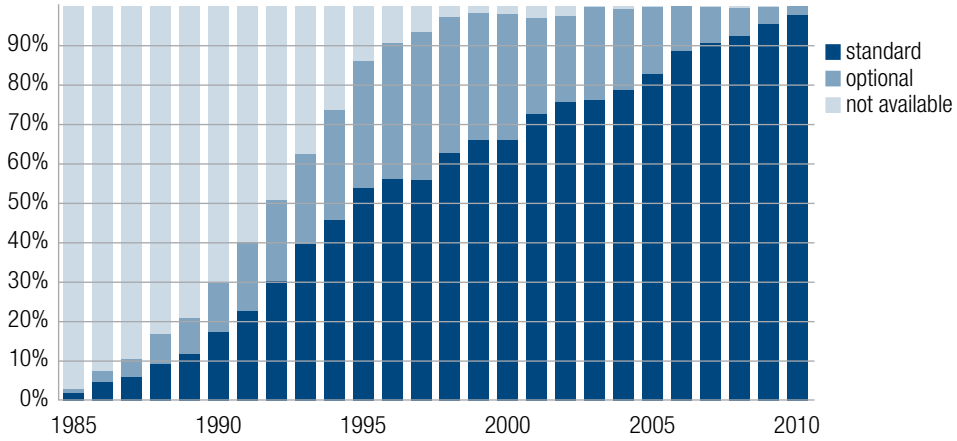

Figure 1 shows the percentage of vehicle series by model year with either standard or optional ABS. ABS first appeared on the 1971 Chrysler Imperial. However, modern ABS has been continuously available since model year 1985. By the 1990 model year had become standard on 17% and optional on 12% of vehicle series. For the 2010 model year, ABS was standard on 99% and optional on 1% of vehicle series.

Figure 2: Percentage of registered vehicles with ABS

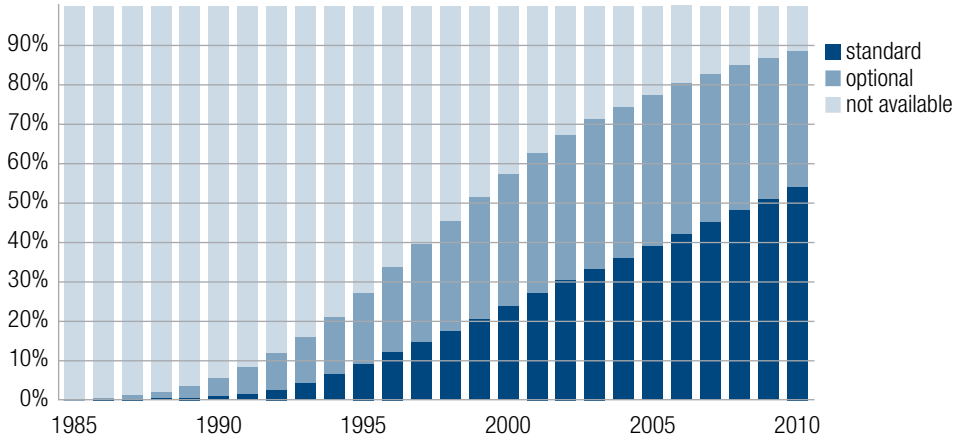

Figure 2 shows the percentage of registered vehicles by calendar year with either standard or optional ABS. By 1990, ABS had become standard on only 1% and optional on 5% of registered vehicles. By 2010, ABS was standard or optional on 88% of registered vehicles.

Figure 3: Predicted percentage of registered vehicles with ABS

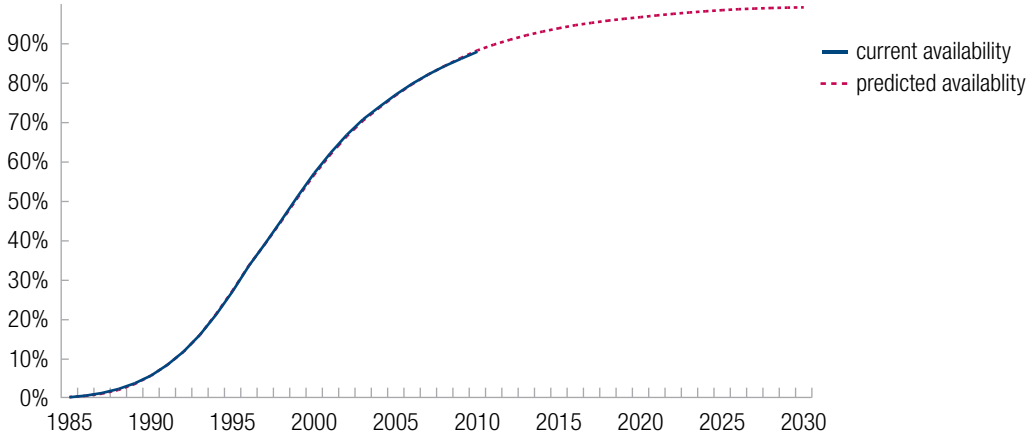

Figure 3 shows the percentage of predicted registered vehicles by calendar year with ABS. It is predicted that ABS will be standard or optional on 95% of registered vehicles in 2015 and 100% by 2030.

Figure 4: Percentage of new vehicle series with ESC

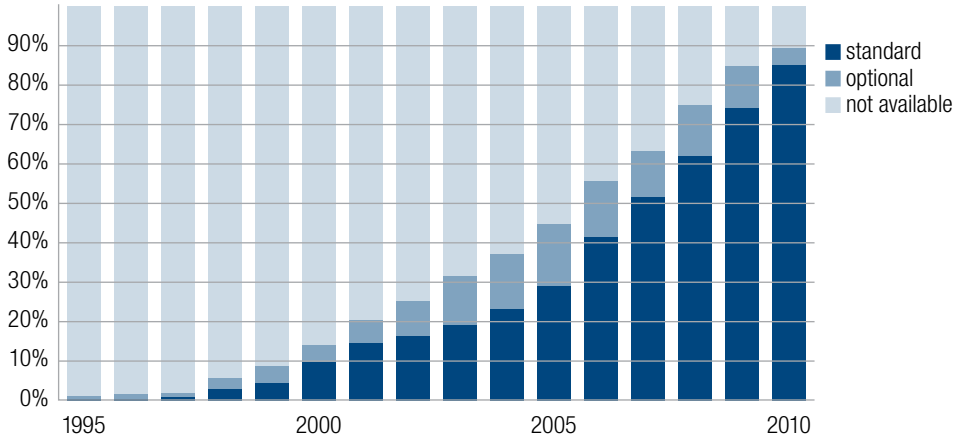

Figure 4 shows the percentage of vehicle series by model year with either standard or optional ESC. ESC was introduced in model year 1995 and by the 2000 model year had become standard on 10% and optional on 4% of vehicle series. For the 2010 model year, ESC was standard on 91% and optional on 4% of vehicle series.

Figure 5: Percentage of registered vehicles with ESC

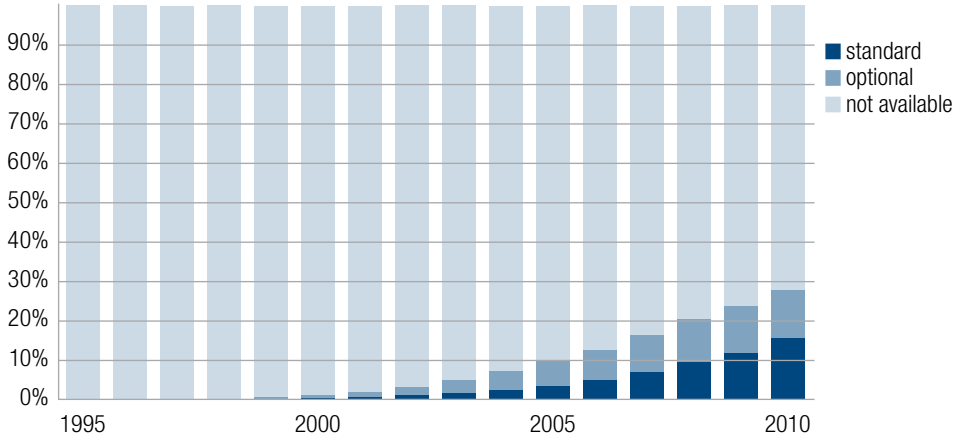

Figure 5 shows the percentage of registered vehicles by calendar year with either standard or optional ESC. By 2000, ESC had become standard on less than 1% and optional on 1% of registered vehicles. By 2010, ESC was standard or optional on 27% of registered vehicles.

Figure 6: Predicted percentage of registered vehicles with ESC

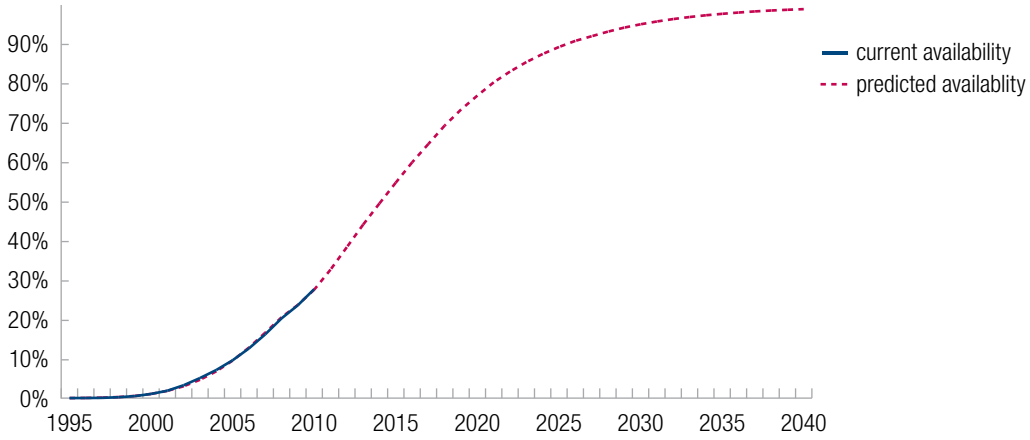

Figure 6 shows the percentage of predicted registered vehicles by calendar year with ESC. It is predicted that ESC will be standard or optional on 95% of registered vehicles in 2029 and 100% by 2040.

Figure 7: Percentage of new vehicle series with driver front airbags

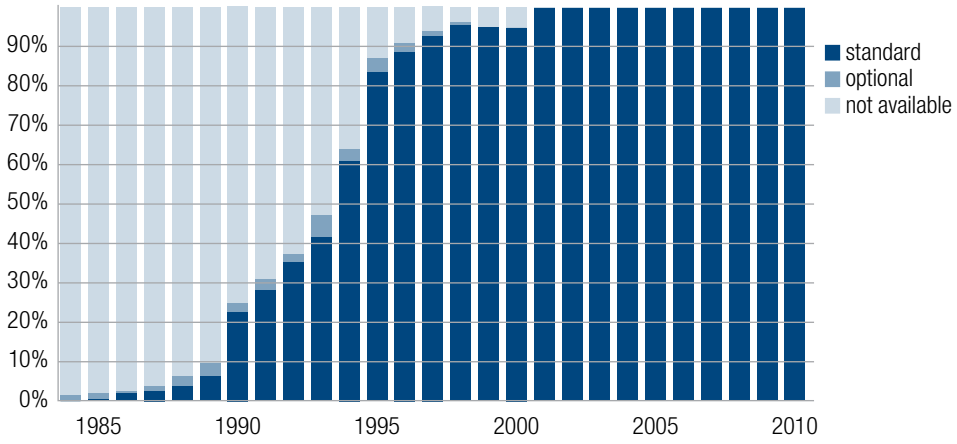

Figure 7 shows the percentage of vehicle series by model year with either a standard or optional driver front airbag.The driver front airbag has been continuously available since model year 1984. However, front airbags were installed on a limited number of General Motors vehicles in the mid-1970s. Federal law began requiring driver frontal airbags on some vehicles starting in 1996. By the 1990 model year driver front airbags had become standard on 23% and optional on 2% of HLDI series. By the 2001 model year, driver front airbags were standard on virtually all HLDI series.

Figure 8: Percentage of registered vehicles with driver front airbags

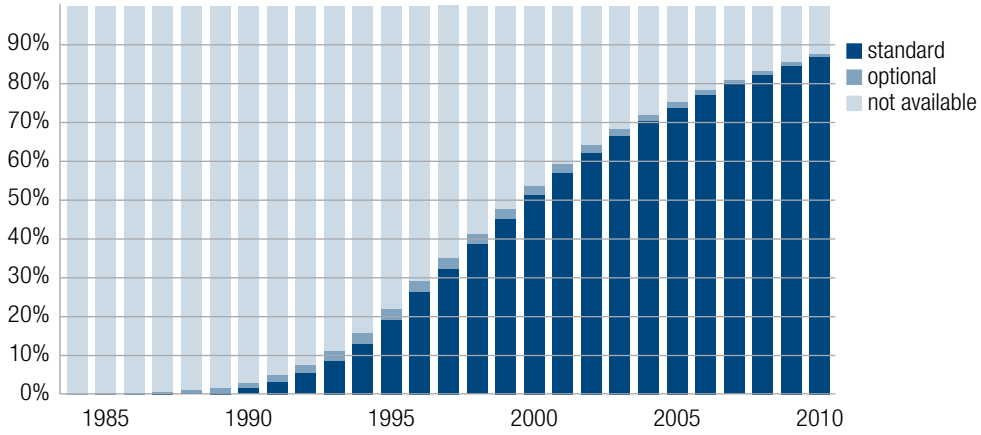

Figure 8 shows the percentage of registered vehicles by calendar year with either a standard or optional driver front airbag. By 1990, a driver front airbag had become standard on only 1% and optional on 2% of registered vehicles. By 2010, driver front airbags were standard or optional on 88% of registered vehicles.

Figure 9: Predicted percentage of registered vehicles with driver front airbags

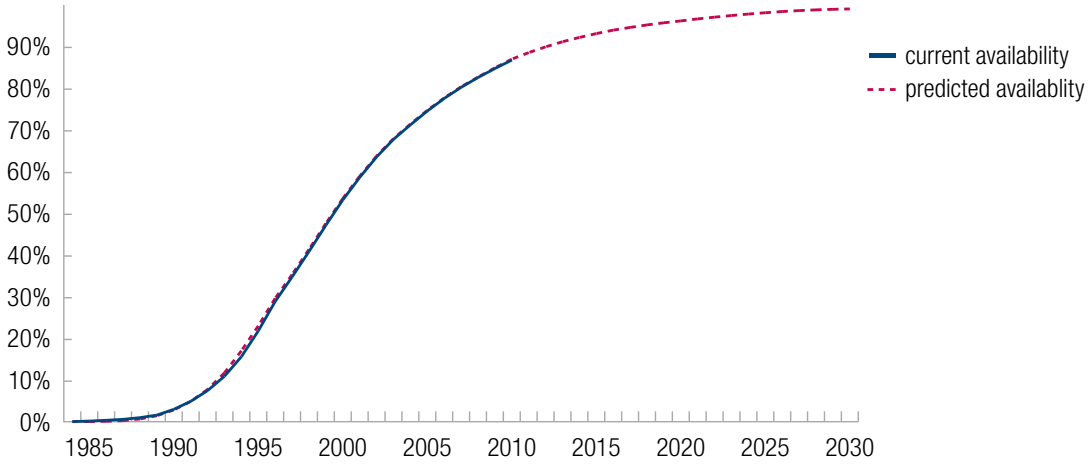

Figure 9 shows the percentage of predicted registered vehicles by calendar year with either a standard or optional driver front airbag. It is predicted that a driver front airbag will be standard or optional on 95% of registered vehicles in 2016 and 100% by 2030.

Figure 10: Percentage of new vehicle series with driver side airbags

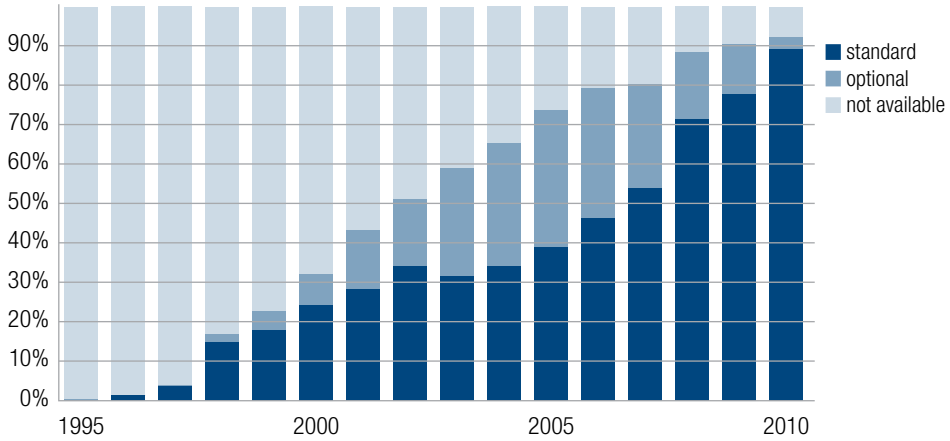

Figure 10 shows the percentage of vehicle series by model year with either a standard or optional driver side airbag. The driver side airbag was introduced in model year 1995 and by the 2000 model year had become standard on 24% and optional on 8% of vehicle series. For the 2010 model year, driver side airbags were standard on 92% and optional on 4% of vehicle series.

Figure 11: Percentage of registered vehicles with driver side airbags

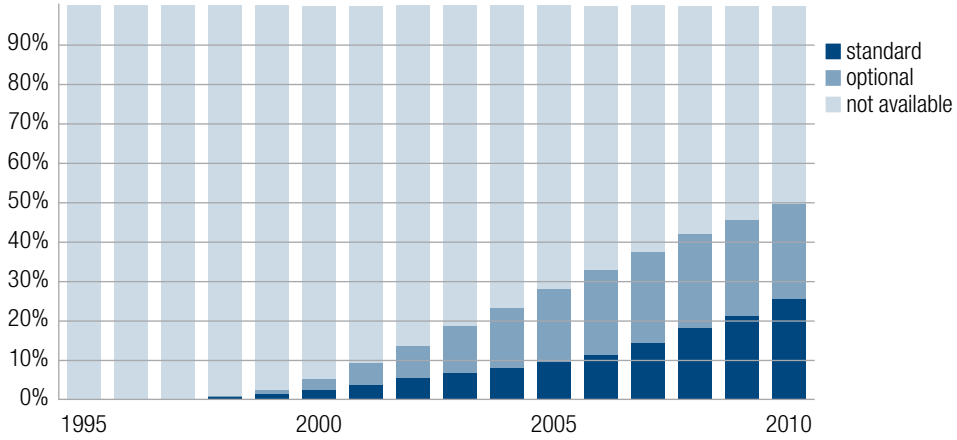

Figure 11 shows the percentage of registered vehicles by calendar year with either a standard or optional driver side airbag. By 2000, driver side airbags had become standard on less than 2% and optional on 3% of registered vehicles. By 2010, a driver side airbag was standard or optional on 49% of registered vehicles.

Figure 12: Predicted percentage of registered vehicles with driver side airbags

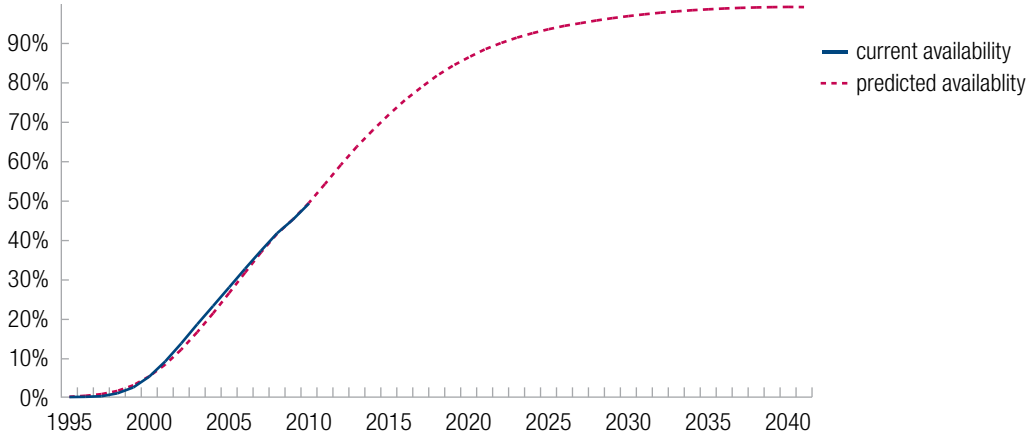

Figure 12 shows the percentage of predicted registered vehicles by calendar year with either a standard or optional driver side airbag. It is predicted that a driver side airbag will be standard or optional on 95% of registered vehicles in 2026 and 100% by 2040.

Figure 13: Percentage of new vehicle series with driver side head-protecting airbags

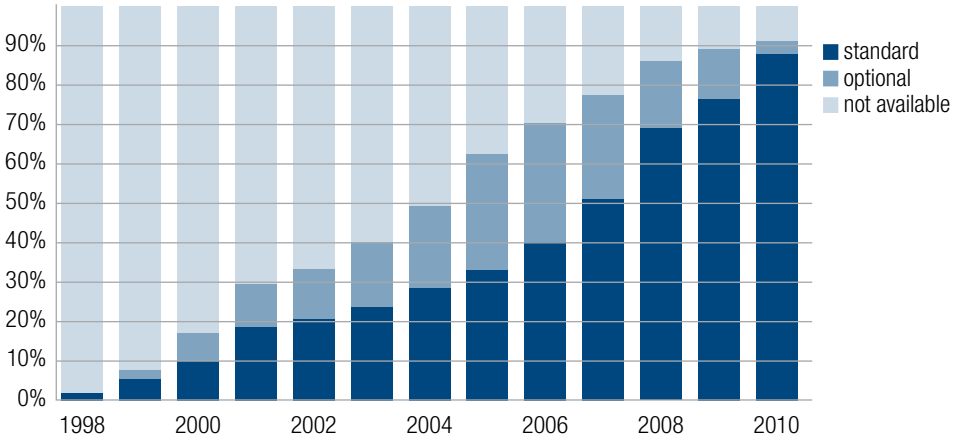

Figure 13 shows the percentage of vehicle series by model year with either a standard or optional head-protecting driver side airbag. The head-protecting driver side airbag was introduced in model year 1998 and by the 2005 model year had become standard on 33% and optional on 29% of vehicle series. For the 2010 model year, head-protecting driver side airbags were standard on 88% and optional on 3% of vehicle series.

Figure 14: Percentage of registered vehicles with driver side head-protecting airbags

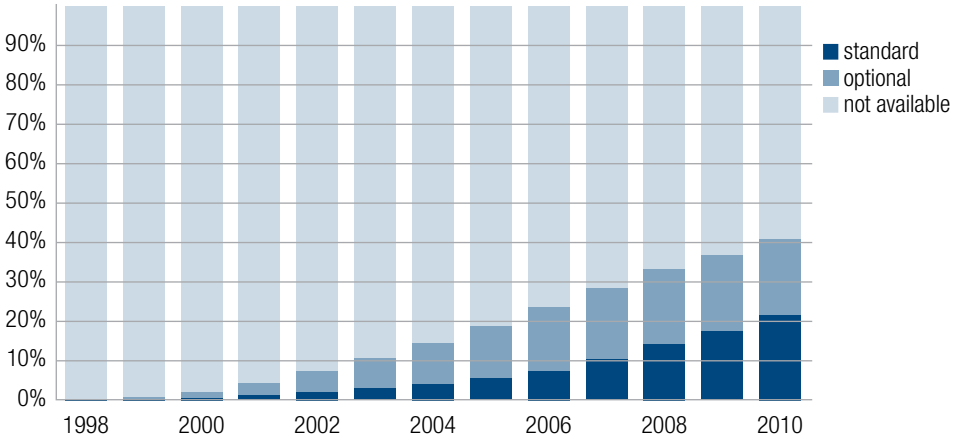

Figure 14 shows the percentage of registered vehicles by calendar year with either a standard or optional head-protecting driver side airbag. By 2005, head-protecting driver side airbags had become standard on less than 5% and optional on 13% of registered vehicles. By 2010, a head-protecting driver side airbag was standard or optional on 41% of registered vehicles.

Figure 15: Predicted percentage of registered vehicles with driver side head-protecting airbags

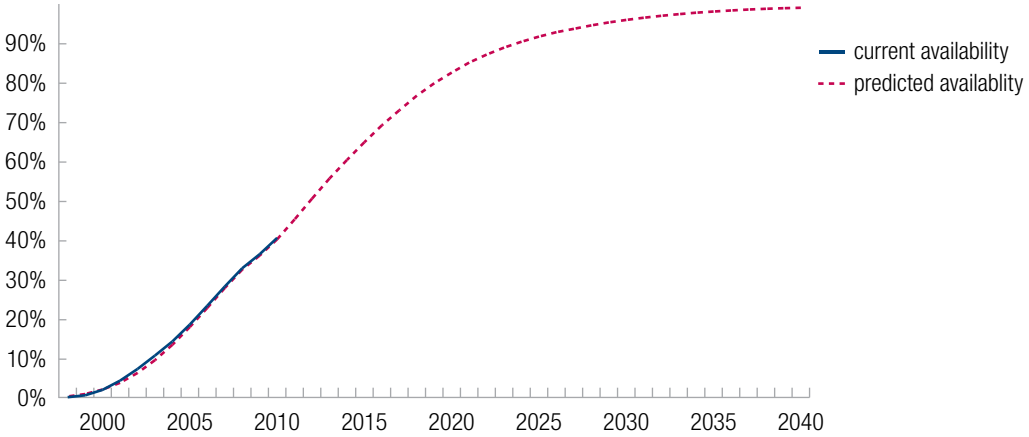

Figure 15 shows the percentage of predicted registered vehicles by calendar year with either a standard or optional head-protecting driver side airbag. It is predicted that a head-protecting driver side airbag will be standard or optional on 95% of registered vehicles in 2028 and 100% by 2040.

Figure 16: Percentage of new vehicle series with forward collision warning

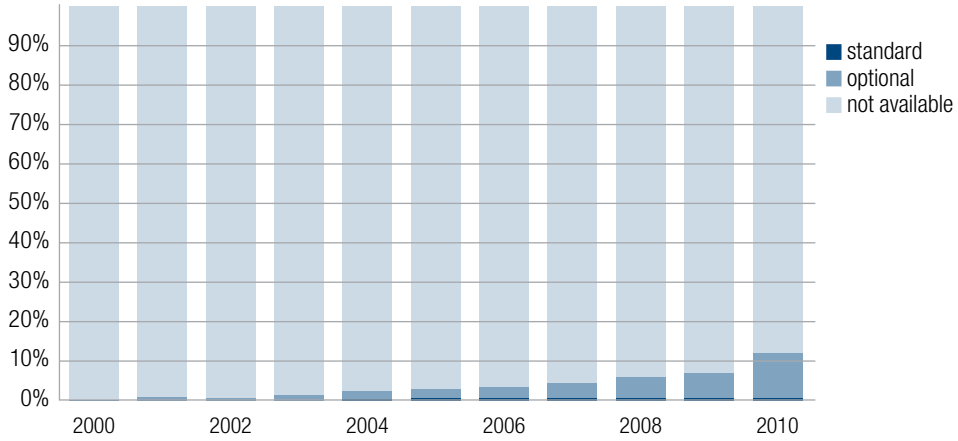

Figure 16 shows the percentage of vehicle series by model year with either standard or optional forward collision warning. Forward collision warning was introduced in model year 2000 and by the 2005 model year had become standard on 1% and optional on 2% of vehicle series. For the 2010 model year, forward collision warning was standard on 1% and optional on 11% of vehicle series.

Figure 17: Percentage of registered vehicles with forward collision warning

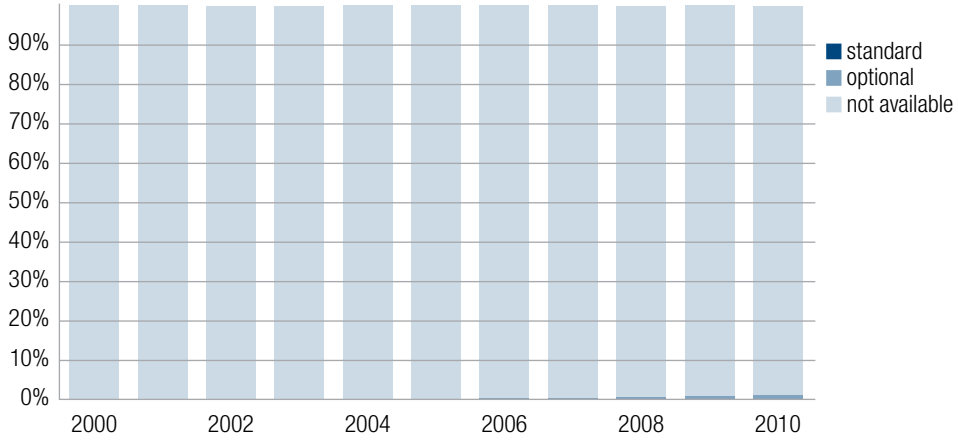

Figure 17 shows the percentage of registered vehicles by calendar year with either standard or optional forward collision warning. By 2005, forward collision warning had become standard on less than 1% and optional on less than 1% of registered vehicles. By 2010, forward collision warning was standard or optional on 1% of registered vehicles.

Figure 18: Predicted percentage of registered vehicles with forward collision warning

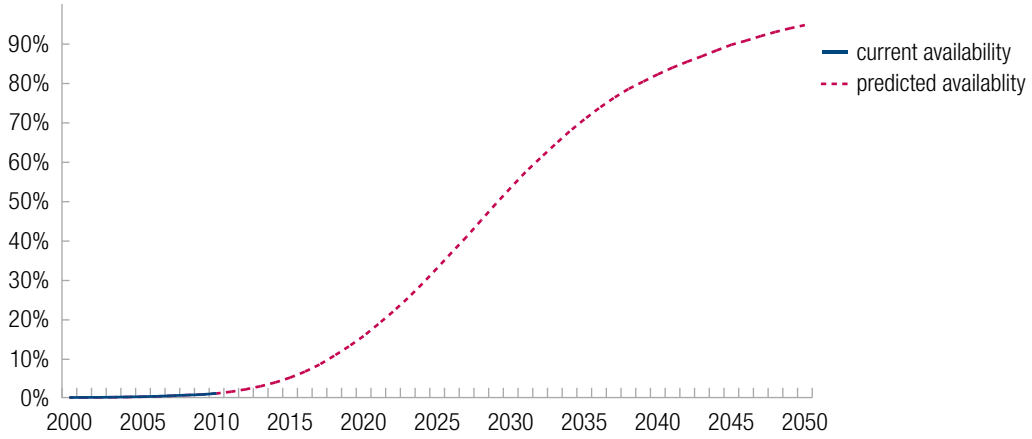

Figure 18 shows the percentage of predicted registered vehicles by calendar year with either standard or optional forward collision warning. It is predicted that forward collision warning will be standard or optional on 95% of registered vehicles in 2049.

Discussion

It takes a long time for new vehicle features to spread through the registered vehicle fleet. Even when features are required by NHTSA, it takes many years for features to be available on all vehicles. Frontal airbags for example, were first available to consumers in 1984 and by calendar year 2000 most vehicles used by private passengers were required to have frontal airbags to protect the driver. However, in calendar year 2010 (ten years later) there were still an estimated 13 percent of vehicles registered without this feature available. Forward collision warning systems were first introduced in the U.S. market in 1999 and by calendar year 2010 the feature was still only available on 1.1 percent of registered vehicles. If the prevalence of FCW continues to grow on the same path, it will take until 2050 for the feature to be available on 95 percent of vehicles. If all new vehicles were to be equipped with FCW starting in model year 2013, it would still take until 2034 for the feature to be available on 95 percent of vehicles.

Limitations

One limitation of the logistic model with a probit link is that it assumes a distribution with an asymptote of 100 percent, which it approaches slowly towards the end of the distribution. When a given feature's prevalence reaches 95 percent, its growth substanstially slows and it takes a number of years to capture the remaining 5 percent. It is not known how this remaining small percentage will be captured since no feature has reached 100 percent prevalence yet. The model was carefully chosen to fit the existing (past year) data well, and there is reason to believe that it does not adequately describe the future data. It may be the case that the full 100 percent prevalence is never reached, as some people tend to keep old cars as collectable vehicles. Finally, the goal of the study was to estimate when each feature will be available for the vast majority of the fleet, not 100 percent of the fleet.

Another limitation is that the prediction was based on the coarse calendar/model year registration counts rather than stratified by make and series. However, the stratified approach would be difficult if not impossible to accomplish. The future is uncertain, and so is the future new-model fleet. Even with the present approach, a bold assumption of stalled vehicle sales had to be made. Making further assumptions on which makes and series will be popular in the future or which manufacturers will introduce safety features more aggressively is beyond the scope of this analysis. However, as mentioned previously and reflected in the graphs, the model fits the existing data well, and consequently it is reasonable to believe that the predictions for the future fleet are the best possible.

References

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