



Methodological notes

PIN Flash Nr.13

1. The estimation of deaths prevented due to improved occupant safety of vehicles and the ESC fitment

The following estimation is based on the injury reduction potential of vehicles in respect to the Euro NCAP safety ratings estimated by Lie and Tingvall (2003). It is based on the fact that the new cars represented in recent years (except 2008) 6%¹ of the total car fleet, an assumption that occupants killed in them in their first year of use form the same proportion of all car occupants killed in that year (given their relatively higher usage rate but compensated by the lower accident risk of their users and active safety equipment), and a further assumption that the same number of deaths that are prevented in the first year of use of new cars will be prevented in each subsequent year of their use during the timescale of this analysis.

It has been estimated, that an increase in occupant protection from one additional star, e.g. from 2 to 3 stars or 4 to 5 stars, reduces the risk of fatal injury by 12%². This is a conservative estimates, as the 12% estimate refers to both sever and fatal injury, while the effect is higher on fatal injury.

The risk reduction and risk differences are therefore calculated as the change of star average times 12% as follows:

- Risk reduction over the period 1998-2007 for EU-27: average star score 4.5 compared to average star score of 3.1: $(4.49-2.15)*12 = 28\%$
- Risk difference best and worst performing countries: $(4.7 - 3.9)*12 = 10\%$
- Risk difference best performing countries and EU-27: $(4.7 - 4.5)*12 = 2.4\%$

We may now estimate the number of deaths prevented in the first year of use of new cars due to vehicle passive safety improvements from the number of fatalities in new cars and the relevant risk reduction rate 100R per cent as follows. The number of deaths prevented is difference between the number that would have occurred without the improvements and the number that actually occurred. This is the actual number multiplied by $[1/(1-R)-1]$, which is equal to the actual number multiplied by $R/(1-R)$.

The number of lives saved in EU-27 among users of new cars over the past year (from 2007 to 2008), supposing an average fatality reduction rate of 3.1% is thus estimated as $1,820 \times 0.031 / 0.969 = 58$.

¹ Latest Report on motor vehicles in use in Europe 2007 by ANFAC - 2009 Edition (Spanish Automobile Association)

² Lie, A. and Tingvall, C. (2002). How Do Euro NCAP Results Correlate with Real-Life Injury Risks? A Paired Comparison Study of Car-to-Car Crashes, *Traffic Injury prevention*, 3, pp. 288-293

To calculate the contribution to the EU reduction target one must have the number of fatalities in new cars and the risk reduction in new cars due to a specific safety feature for each year, in this case Euro NCAP star rating and ESC fitment.

We do apply an assumption that the risk reduction in new cars sold for each year is the same as the risk reduction of tested cars by Euro NCAP in the previous year. (Newly sold cars are not necessary those just introduced to the market and tested the same year).

As before, the risk reduction is calculated based on the assumption that an increase in star score by one star will bring down the fatal injury risk of car occupants by 12%.

The percentage risk reduction for tested models is linearly interpolated from the known 1998-2007 reduction of 28% arrived at as $(4.49-2.15)*12$.

The number of killed car occupants is estimated from the known number of car occupant deaths in 15 EU countries (retrieved from CARE and IRTAD databases), based on the assumption that car occupant deaths in Germany represent 64% of all deaths and in other (CEEC) 42% of all deaths. The estimates are then rounded to hundreds. The annual renewal rate registered in 2007 is assumed to hold over the entire period as well.

| Year | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|-------------------------|--------|--------|--------|--------|--------|--------|--------|
| Total road deaths | 54,363 | 53,414 | 50,41 | 47,367 | 45,356 | 43,125 | 42,759 |
| Vehicle occupant deaths | 33,440 | 32,300 | 31,600 | 29,600 | 27,300 | 26,000 | 24,300 |

Table 1: Road deaths and estimated passenger car deaths in EU-27

The numbers in Table 1 are then used to estimate the number of prevented car occupant deaths in the EU-27 done in Table 2.

| Year | Risk reduction (tested models) | Risk reduction (sold models) | Killed occupants in new cars (sold) | Prevented deaths(compared with 1998) | Prevented deaths (past decade, cumulative) | Prevented deaths (compared with 2001) | Prevented deaths (since 2001, cumulative) |
|--------------|--------------------------------|------------------------------|-------------------------------------|--------------------------------------|--|---------------------------------------|---|
| 1998 | 0.0% | 0% | 2,422 | | 0 | | |
| 1999 | 2.4% | 0% | 2,429 | | 0 | | |
| 2000 | 4.8% | 2% | 2,408 | 59 | 59 | | |
| 2001 | 7.6% | 5% | 2,359 | 119 | 178 | 0 | |
| 2002 | 10.4% | 8% | 2,338 | 192 | 370 | 67 | 67 |
| 2003 | 13.2% | 10% | 2,261 | 262 | 633 | 134 | 201 |
| 2004 | 16.0% | 13% | 2,212 | 336 | 969 | 203 | 404 |
| 2005 | 19.0% | 16% | 2,072 | 395 | 1,364 | 261 | 666 |
| 2006 | 22.0% | 19% | 1,911 | 448 | 1,812 | 316 | 982 |
| 2007 | 25.0% | 22% | 1,820 | 513 | 2,326 | 378 | 1,360 |
| 2008 | 28.0% | 25% | 1,701 | 567 | 2,893 | 431 | 1,791 |
| Total | | | | | 10,640 | | 5,471 |

Table 2: Estimation of prevented passenger car deaths since 1998 in EU-27 thanks to increased occupant protection

The improvement in occupant protection in crashes has prevented from deaths some 10,640 people over the past decade and 5,471 car occupant deaths were prevented since 2001.

Under the present trend, there will be 10,410 prevented deaths by 2010 for the period 2001-2010, what now represents a 3% reduction in the total number of deaths over that period.

Under the current trend, the number of prevented deaths in 2010 will be 2,870. The expected number of occupant deaths in 2010 is 20,900, so the number prevented is 14% of .the number that will still occur.

Similarly, one may estimate the contribution of ESC fitment to the reduction in road fatalities in EU-27. The calculation is based on the assumption that the ESC has an estimated 20%³ reduction potential in respect to car occupant fatalities.

On average, the ESC was fitted as standard on 69.6% of newly sold passenger cars in EU-27 (excluding CY+MT) in 2008 and 62.2% in 2007, while we suppose that it was zero in 1998. A linear trend in market penetration is assumed.

| Year | ESC fitment | Killed occupants in new cars (total) | Risk reduction | Prevented deaths(compared with 1998) | Prevented deaths (past decade, cumulative) | Prevented deaths (compared with 2001) | Prevented deaths (since 2001, cumulative) |
|--------------|-------------|--------------------------------------|----------------|--------------------------------------|--|---------------------------------------|---|
| 1998 | 0% | 2422 | 0% | 0 | | | |
| 1999 | 7% | 2429 | 1% | 34 | 34 | | |
| 2000 | 14% | 2408 | 3% | 69 | 104 | | |
| 2001 | 21% | 2359 | 4% | 103 | 207 | 0 | |
| 2002 | 28% | 2,338 | 6% | 139 | 346 | 33 | 33 |
| 2003 | 35% | 2,261 | 7% | 170 | 516 | 65 | 98 |
| 2004 | 42% | 2,212 | 8% | 203 | 719 | 97 | 195 |
| 2005 | 49% | 2,072 | 10% | 225 | 944 | 123 | 318 |
| 2006 | 56% | 1,911 | 11% | 241 | 1,185 | 144 | 462 |
| 2007 | 63% | 1,820 | 13% | 262 | 1,448 | 167 | 629 |
| 2008 | 70% | 1,701 | 14% | 277 | 1,724 | 185 | 814 |
| Total | | | | | 7,228 | | 2,550 |

Table 3: Estimation of prevented passenger car deaths since 1998 in EU-27 thanks to ESC

The fitment of ESP in passenger cars helped prevented 7,228 occupant deaths since 1998 and 2,550 since 2001.

Last, but not least, the simultaneous fatality reduction effect of both occupant protection and the ESP fitment could be estimated under the formula: $R=1-(1-R_{OP})*(1-R_{ESP})$, where R stands for the total risk reduction, and the R_{OP} and R_{ESP} stands for the reduction potential of occupant passive safety and ESP.

³ Lie, A. and Tingvall, C. (2004). The effectiveness of ESP in reducing real life accidents, Traffic Injury Prevention, 5 , 37-41

By 2010, the total reduction for the past decade would be 15,112 and this reduction since 2001 would be 6,689.

| Year | Killed occupants in new cars (total) | Risk reduction | Prevented deaths (compared with 1998) | Prevented deaths (since 1999, cumulative) | Prevented deaths (compared with 2001) | Prevented deaths (since 2001, cumulative) |
|--------------|--------------------------------------|----------------|---------------------------------------|---|---------------------------------------|---|
| 1998 | 2,422 | 0% | 0 | 0 | | |
| 1999 | 2,429 | 1% | 34 | 34 | | |
| 2000 | 2,408 | 5% | 124 | 158 | | |
| 2001 | 2,359 | 9% | 208 | 365 | 0 | |
| 2002 | 2,338 | 13% | 299 | 664 | 93 | 93 |
| 2003 | 2,261 | 17% | 377 | 1,041 | 178 | 271 |
| 2004 | 2,212 | 20% | 453 | 1,494 | 259 | 530 |
| 2005 | 2,072 | 24% | 502 | 1,996 | 320 | 849 |
| 2006 | 1,911 | 28% | 536 | 2,533 | 368 | 1,218 |
| 2007 | 1,820 | 32% | 579 | 3,112 | 419 | 1,637 |
| 2008 | 1,701 | 36% | 604 | 3,716 | 454 | 2,091 |
| Total | | | | 15,112 | | 6,689 |

Table 4: Estimation of prevented passenger car deaths since 1998 in EU-27 thanks to simultaneous effect of increased occupant protection and ESC fitment

2. The correlation between different Euro NCAP variables

The following correlation matrix is based on the Euro NCAP test results for 207 unique models sold in 2008. Five variables are considered and the correlation coefficients estimated.

| Variable | OccStars | PedScore | PedStars | ChildStars | SBR |
|------------|----------|----------|----------|-------------|-------------|
| OccScore | 0,92 | 0,31 | 0,25 | 0,39 | 0,76 |
| OccStars | | 0,26 | 0,20 | 0,35 | 0,68 |
| PedScore | | | 0,91 | 0,33 | 0,07 |
| PedStars | | | | 0,16 | 0,30 |
| ChildStars | | | | | 0,26 |

Table 5: Correlation coefficients for key variables of Euro NCAP tests

There is a strong positive correlation between occupant score/star and SBR rating, which may partly reflect the fact that the presence of SBR has resulted in additional points in occupant protection score, but above all the fact that models ranking high on passive safety also rank high on active safety. There is a medium positive correlation between occupant score/star and child stars, meaning that models offering high occupant protection also tend to offer rather high protection to child in a restraint. A weak correlation between occupant star/score and pedestrian score/star points to the lack of link between occupant and pedestrian protection.

3. Sales data background

The vehicle sales data together with Euro NCAP crash test scores create a basis for the analyses made in this Flash.

The vehicle sales data were purchased from R. L. Polk Germany GmbH and consist of 2007 and “year to date” (YTD) monthly data of 2008. They refer to purely new registrations / new sales which mean that only the pure first registration of a vehicle is within the database. All vehicles which had previously been registered in a specific country or any other foreign country will be registered as used cars in a separate used cars database. Nevertheless, as it is uncontrollable if vehicles that are imported by private persons were registered before, it is possible that they are again shown into the new registrations database. A vehicle that was registered for a short-term before is registered as a used vehicle the second time.

The unique identification of a car is allowed through combining name of the manufacturer, name of the model and the model year. Under the model year, the introduction year of the particular model generation is meant. So, the new derivatives of a generation, that are added later, still receive the original introduction year, in order to express the relation to its generation.

The EuroNCAP crash test results database was obtained through the SRA and contains crash test results of some 210 different car models. The scores and corresponding star ratings are available for occupant protection, child protection, pedestrian protection and seat belt reminder equipment.





The Pre 2009 rating scheme was applied instead of the 2009 rating scheme as it allows considering a great proportion of sold cars. Under the new scheme, only a small proportion of models, those tested in last months, would have been considered.

For each unique model (make+model+year), the following Euro NCAP variables were available: Class Nr., Class, Front occupant protection score, Side occupant protection score, Occupant protection stars, Child protection stars, Pedestrian protection star, Total occupant protection score, Seat belt reminder.

4. Euro NCAP rating system background

The following tables summarize the correspondence between scores and stars in pre-2008 Euro NCAP protocols.

Occupant protection

| | | | | | |
|------------------------------|---|---|---|--|---|
| Occupant stars |  |  |  |  |  |
| Score in points | 1-8 | 9-16 | 17-24 | 25-32 | 33-37 |
| Percentage score (out of 35) | 3-23% | 26-46% | 49-69% | 71-91% | 94-100% |

The tested car may obtain 16 points in the offset frontal impact test, 16 points in the side impact test, up to two points in the side impact pole test and up to three points for having a seatbelt reminder system. As the pole impact test was not mandatory, the total score here is

the sum of the offset frontal impact test, side impact test and SBR only. Thus the percentage score is arrived at by dividing the scores by the reachable maximum of 35 points.

Child protection

| | | | | | |
|---------------------------------|-------|--------|--------|--------|-------|
| Child stars | ★ | ★★ | ★★★ | ★★★★ | ★★★★★ |
| Score in points | 1-12 | 13-24 | 25-36 | 37-48 | 49-60 |
| Percentage score (out of 49) | 2-24% | 26-49% | 51-73% | 76-98% | |

The Euro NCAP separately rewards the availability of SBR on different seats in the vehicle. One point is available for each of the driver, front seat passenger and rear seats for those systems that pass the assessment.

Seat belt reminder (SBR)

| | | | | |
|-----------------|--------|-------------|----------------------|---------------|
| SBR points | 0 | 1 | 2 | 3 |
| Score in points | No SBR | Driver seat | Front seat passenger | All occupants |

The child protection rating is for a combination of a car with specific child seats that have been recommended by the car manufacturer. The score depends on the child seat dynamic performance in front and side impact tests but also on the fitting instructions for the child restraints, airbag warning labels, and the car's ability to accommodate the child restraints safely. Currently, the maximum number of points that can be awarded is 49. Thus, the 49 benchmark is used instead of 60. (However, if there are further developments, the Star Rating system allows for further points to be awarded in the future.)

Only the star rating was available for the analysis, thus no evaluation was done based on scores and percentages score here.

Pedestrian protection

| | | | | | |
|--|-------|--------|--------|--------|---------|
| Pedestrian stars | ★ | ★★ | ★★★ | ★★★★ | ★★★★★ |
| Score | 1-8 | 9-16 | 17-24 | 25-32 | 33-36 |
| Percentage score (not available for analysis) | 3-22% | 25-44% | 47-67% | 69-89% | 92-100% |

The pedestrian protection rating is based on the adult and child head form tests and the two leg form tests. Only the star rating was available for the analysis, thus no evaluation was done based on scores and percentages score.

5. Total sales data for EU-27

Total vehicles sold and proportion of tested by Euro NCAP from the dataset provided by POLK.

| Period | 2007 | 2008* | I-IX 2008 |
|----------------------------|------------|------------|------------|
| Total sold | 15,772,674 | 14,187,176 | 11,573,356 |
| Occupant protection tested | 14,448,451 | 13,068,486 | 10,663,198 |
| Child protection tested | 10,259,448 | 10,389,075 | 8,403,025 |
| Proportion occupants | 0,916 | 0,921 | 0,921 |
| Proportion child | 0,651 | 0,732 | 0,726 |

Table 6: True car sales, number of car sold tested for occupant and child protection together and their share

Note that 2008 data do not cover sales in the entire year 2008 for certain countries.