Frontal Impact Protection

German Accident Data Analysis II


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What are we talking about ....? 

Car Occupant Fatalities 2008

What can we see....?

- **Single Car** is first (42%)
- **Single Frontal** is a big subgroup (20%)
- **Car to Car** is second (24%)
- **Front – Front** is a big subgroup (12%)
• It does not depend so much on what car you are sitting in
• It depends more on which car you are hitting

\[ \text{Injury Risk}_A = \text{function (} CWA, D_{AB}, S \text{)} \]

- Partner Prot. \( D_{AB} \)
- Self Prot. \( CWA \)
- Accident Sev. \( S \)

CWA is a function of Gender, Age ... Mass, Star Rating ...
So, what cars do we hit?
Mass Ratio Distribution in Crashes
1983 - 1996

Percentage

0.0 - 0.1
0.3 - 0.4
0.5 - 0.6
0.7 - 0.8
0.9 - 1
1.1 - 1.2
1.3 - 1.4
1.5 - 1.6
1.7 - 1.8
1.9 - 2

Mass Ratio

Standard Deviation
1983 - 1992 = 0.31
1992 - 1996 = 0.28

Pete Thomas 1998 ...
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BASt, Germany
Look back in time... and today

Mass Ratio Distribution in Crashes
1983 - 1996

P. Thomas, R. Frampton
1998 / Dearborn

Mass Ratio distribution is quite unchanged!

Standard Deviation
1983 - 1992 = 0.31
1992 - 1996 = 0.28
2005 - 2008 = 0.36
All Segments became more massive, keeping geometric size similar.
Do we have a problem with big cars?

“It’s a vehicle suitable for both the defensive and the offensive driver.”

New Yorker — March 9, 1998
In which cars do people die?

We have a problem with Compact, Small and Mini Cars!
... and currently we still have a problem with older cars!

Less than 10% of fatalities happen in new cars!
In which cars do people die?

Fatalities in new vehicles happen again in small cars

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• We have a problem with Compact, Small and Mini Cars!

• ... and currently we still have a problem with older cars!

• For new cars fatalities happen again in small cars

  Whom do they collide with?
Masses of vehicles colliding in **serious** front-front accidents

Mosaic Plot

Visualisation of a contingency table

Area ~ Count

Color ~ „unusual value“
Masses of vehicles colliding in **serious** front-front accidents

It is clear that **Mass Differences are a potential thread**; thus it is clear that:

- **High/Low Mass Ratios are overly represented** (blue areas)

where as

- **Mass Ratios of 1 are underrepresented** (red areas)

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High Mass Differences are especially a reason for fatal crashes although High Mass Differences do not represent the highest share.
Masses of new vehicles colliding in serious front-front accidents

For new cars no combination is generally overrepresented.

New Cars are heavier probably keeping the same relative speed.

For new cars there is more kinetic energy in the crash.
Masses of new vehicles colliding in fatal front-front accidents

High Mass Differences are slightly overrepresented for fatal new cars

Older fleet showed higher mass incompatibility,
High Mass Differences are slightly overrepresented for fatal new cars.

Older fleet showed higher mass incompatibility, probably because of lower self protection level.
Whom do they collide with?

- Small cars have an overly proportional number of accidents with big cars

but

- Most of small cars accidents happen in a moderate Mass Ratio Range
Masses of vehicles colliding in fatal front-front accidents

Obvious Mass Effect!

Mass Ratio 1.5
Fatal Occupant A
Fatal Occupant B
Fatal A+B

Mass Ratio 0.67

Vehicle Weight A
Vehicle Weight B
Masses of new vehicles colliding in fatal front-front accidents

Obvious Mass Effect!
And now... ??

- To estimate influences correctly a paired comparison calculation shall be done
- Both cars in one accident must be looked at simultaneously
- Year of Initial Registration has been added
- German data from 2008 have been added
Paired Comparison (including all Mass Ratio)

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<th>Std</th>
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Based on 4393 serious Front-Front collisions; Bradley Terry Model (R), Random Sampling, Rubin Formula

SAVE
- Bigger Mass
- Offroad Car | Compact | Medium
- New car -> (R94 / NCAP)

DANGEROUS
- Being old
- Being female
### Paired Comparison (Mass Ratio in [0.9:1.1])

| Category                      | Estimate | Std. Error | Pr(>|z|)  |
|-------------------------------|----------|------------|----------|
| AGEGROUP25.44y                | -0.2637  | 0.1458     | 0.07055  |
| AGEGROUP45.64y                | -0.4386  | 0.1474     | 0.00292 **|
| AGEGROUP65.                   | -1.1609  | 0.2183     | 1.0e-07 ***|
| geschlfemale                  | -0.6282  | 0.1254     | 5.4e-07 ***|
| Masse.800.11e.03.             | -0.8696  | 0.7323     | 0.23502  |
| Masse.11e.03.13e.03.          | -0.5286  | 0.7840     | 0.50012  |
| Masse.13e.03.15e.03.          | -0.5808  | 0.8286     | 0.48335  |
| Masse.15e.03.2e.03.           | 0.2642   | 0.9237     | 0.77486  |
| SegmentSmall                  | -0.0253  | 0.3072     | 0.93440  |
| SegmentCompact                | 0.4915   | 0.3514     | 0.16192  |
| SegmentMedium                 | 0.6415   | 0.4167     | 0.12373  |
| SegmentUpper                  | 0.1808   | 0.5446     | 0.73981  |
| SegmentOffroad                | 0.4728   | 0.6022     | 0.43239  |
| SegmentUtil                  | 0.4439   | 0.6124     | 0.46857  |
| SegmentSports                 | 1.3901   | 0.9313     | 0.13552  |
| SegmentVan                   | 0.2397   | 0.4741     | 0.61321  |
| IR.1994.1998.                 | 0.4713   | 0.1698     | 0.00550 **|
| IR.1998.2003.                 | 0.7803   | 0.2054     | 0.00015 ***|
| IR.2003.2008.                | 1.1176   | 0.2611     | 1.9e-05 ***|

**SAVE**
- New car -> (R94)

**DANGEROUS**
- Being old
- Being female

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Based on 848 serious Front-Front collisions;
Bradley Terry Model (R), Random Sampling, Rubin Formula

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Folie 24
• Effect of gender remains constant irrelevant of mass
...women drive not only smaller cars
-> In a direct comparison women are less protected than men ★

• Effect of age remains constant irrelevant of mass
-> In a direct comparison older drivers are less protected than younger ★

• Effect of „Year of Initial Registration“ remains constant
-> In a direct comparison newer cars are safer than older cars √

• Tackling Mass Problems will only solve a smaller part
(high Mass Ratios) of today’s safety problem

• Tackling the Gender Issue will cover a wider range
and will therefore reveal the higher cost benefit rel.
In Depth Data shows that:

**Single Car Frontal impacts** are more probable for:

- Elderly drivers
- Female drivers
- Urban accidents
- New cars
Factors influencing the probability of having a frontal single car impact

Lower speed; Less aggressive driving

ESC ?
Risc of KSI having a **frontal single car impact**

- Hit Pole
- Being old
- Risky Driving ("male")
- Driving an (very) old car
- Driving rural

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Folie 28

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Risc of KSI having a lateral single car impact

DANGEROUS
- Hitting Pole
- Being old
- Risky Driving („male“)
- Driving an older car
- Driving rural

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Mass Effect in Single Car Impacts

There is no real Mass Effect!
Conclusions

- No problem in particular for small cars

- Gender Issue, but „male“ stands for risky driving. Real Gender Issue need to be investigated In-Depth

- Age Issue,
  [difficult - but important (demographic development) - to deal with]
  -> Dynamic Demographics: Difficult to estimate benefit accurately

- Frontal impact regulation has been more effective for car to car collisions

- Side Impact regulation + NCAP seemed to have been more effective in (lateral) single vehicle collisions
Merci de votre attention!

Thanks for your attention!

Danke für Ihre Aufmerksamkeit!