Educational Workshop Pricing
ASTIN Panama 2017

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First touchpoint with Panama
Agenda

1. Model design

2. Case study: Annual Mileage and BMS in German Motor Pricing
1. Model design

1.1 General remarks

1.2 Reasons for tariff differentiation

1.3 Selection of the relevant tariff criteria

1.4 Definition of classes for tariff criteria

1.5 Dependencies

1.6 GLM

1.7 Lifetime value

1.8 Principles on model selection and use of methods

1.9 Internal and external framework
1. Model design

1.1 General remarks

Separate models for Frequency and average claim cost vs. burning cost model

- Actuarial judgement of fitting quality

- Practical reasons: available data amount; explanatory power could be better for separate models

Additive or multiplicative model

- Check by distance analysis

- Multiplicative for pricing in most cases more adequate

Random variations

- One needs a surcharge to make sure that a company financially survives randomly high claims amounts
1. Model design

1.1 General remarks

Check additive vs multiplicative for a dichotomic criterion
1. Model design

1.1 General remarks

Why do we need underwriting rules additionally to pricing?

In some cases it’s not sufficient to apply high prices to high risks:

This holds
- for non-payment because intended non-payment cannot be avoided by high prices but has to be checked in advance

- for very high risk beyond realistic prices: list of most stolen cars in Germany (up to 1 out of 50) w/o offering coverage for theft

- for fraudulent behaviour: canx in case of too many and/or too severe claims which simultaneously look strange
1. Model design

1.2 Reasons for tariff differentiation

- Avoid negative selection
- Improvement of loss ratio by avoiding of too low prices
- Optimisation of volume and profit
- Improved identification of attractive customer segments (by that more targeted approach)
- Clearly necessary adjustments year on year

- Example substitution: difference commercial to private use around 40%, but almost completely explained by higher type classes (bigger cars), less public sector, more expensive NCD classes => use of several univariate differences in burning cost by just adding up is a wrong approach!!!
## 1. Model design

### 1.2 Avoid negative selection

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Risk group</th>
<th>burning cost</th>
<th>premium Insur. 1</th>
<th>portfolio Insur. 1</th>
<th>premium Insur. 2</th>
<th>portfolio Insur. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>high</td>
<td>600</td>
<td>500</td>
<td>50%</td>
<td>600</td>
<td>50%</td>
<td>40%</td>
</tr>
<tr>
<td>low</td>
<td>400</td>
<td>500</td>
<td>50%</td>
<td>400</td>
<td>50%</td>
<td>60%</td>
</tr>
<tr>
<td>result/total</td>
<td>500</td>
<td>0</td>
<td>100%</td>
<td>0</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year 2</th>
<th>Risk group</th>
<th>burning cost</th>
<th>premium Insur. 1</th>
<th>portfolio Insur. 1</th>
<th>premium Insur. 2</th>
<th>portfolio Insur. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>high</td>
<td>600</td>
<td>500</td>
<td>60%</td>
<td>600</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>low</td>
<td>400</td>
<td>500</td>
<td>40%</td>
<td>400</td>
<td>60%</td>
<td></td>
</tr>
<tr>
<td>result/total</td>
<td>500</td>
<td>-20</td>
<td>100%</td>
<td>0</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>
1. Model design

Example on substitution: Unisex in motor insurance

European legislation: Judgement by European high court

From Dec 21, 2012 onwards pricewise differentiation by sex is not allowed for new business

In Germany the customer has to cancel actively, otherwise the existing contract stays valid => this does not apply for renewing business

In the UK it’s different: all policies are running out at due date
1. Model design: interaction age/sex (age 24 – 81)

Surcharge of ~9% for women compared to men (across all age groups)

Different price compared to men

Age of the driver

Exposure (bars) Relativities (curves)
1. Model design: interaction age/sex (age 17 – 24)

![Graph showing different price compared to women]

- **Different price compared to women**

- Age of the youngest driver
1. Model design: portfolio distribution mileage by sex (partial substitution)
1. Model design: portfolio distribution type class by sex (partial substitution)
1. Model design: Unisex summary

- Sex is not one of the most important criteria. For pricing purposes NCD class, type class, mileage and age are much more relevant.

- The impact on prices by sex can be seen especially for young and older drivers.

- Since Dec 2012 existing (see above) or potential new criteria will substitute sex.

  *currently still open question, but obviously less critical*

- Unisex applies marketwide and impacts consequently the pricing of all competitors but one has to avoid negative selection => potential rate increases.
1. Model design

1.3 Selection of the relevant tariff criteria

- Variable selection by regression (F-Test)
- Stepwise Regression
- Likelihood-Quotient-Test
- GLM (central procedure to detect risk differentiation): Substitution (see commercial use)
- Principal component analysis
- Timewise stability
- Stability between different parts of the portfolio (representative sample hold out to check quality of model)
1. Model design

1.4 Definition of classes for tariff criteria

Helpful for criteria with a lot of parameter value like car type, postcode etc

- Cluster analysis

- Similarity measures (for example distance, neighborhood, expected claims amount)

- Maximise variance between classes and minimise within: homogeneous groups
1. Model design

1.5 Dependencies

- Correlation (assumption normal distribution): disadvantage in case of non-linear relations

- Marginal distributions: analysis by segment

- Copula: see modelling dependency for extremal events

- Dependency of portfolio distribution (contingency table), but for example same burning cost difference possible
1.5 Dependencies: example in the portfolio, but not in frequency

<table>
<thead>
<tr>
<th>Exposure</th>
<th>young</th>
<th>old</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>men</td>
<td>400</td>
<td>200</td>
<td>600</td>
</tr>
<tr>
<td>women</td>
<td>200</td>
<td>400</td>
<td>600</td>
</tr>
<tr>
<td>total</td>
<td>600</td>
<td>600</td>
<td>1200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency</th>
<th>young</th>
<th>old</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>men</td>
<td>40,0%</td>
<td>20,0%</td>
<td>33,3%</td>
</tr>
<tr>
<td>women</td>
<td>20,0%</td>
<td>10,0%</td>
<td>13,3%</td>
</tr>
<tr>
<td>total</td>
<td>33,3%</td>
<td>13,3%</td>
<td>23,3%</td>
</tr>
</tbody>
</table>

More young men and older women, but frequency of men always doubled.
1. Model design

1.5 Dependencies: example not in the portfolio, but in frequency

<table>
<thead>
<tr>
<th>Exposure</th>
<th>young</th>
<th>old</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>men</td>
<td>600</td>
<td>300</td>
<td>900</td>
</tr>
<tr>
<td>women</td>
<td>400</td>
<td>200</td>
<td>600</td>
</tr>
<tr>
<td>total</td>
<td>1000</td>
<td>500</td>
<td>1500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency</th>
<th>young</th>
<th>old</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>men</td>
<td>60,0%</td>
<td>20,0%</td>
<td>46,7%</td>
</tr>
<tr>
<td>women</td>
<td>20,0%</td>
<td>10,0%</td>
<td>16,7%</td>
</tr>
<tr>
<td>total</td>
<td>44,0%</td>
<td>16,0%</td>
<td>34,7%</td>
</tr>
</tbody>
</table>

Always double that much younger than older, but frequency of younger men three times higher than for younger women and of older men only double as high than for older women.
1. Model design

1.5 Dependencies

- Modelling: for example 1 dimension out of 2 criteria

- Example on correlation: arguments from -2 to 2 and square function give corr. zero!!!

\[
\rho_{XY} = \frac{\sum (X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum (X_i - \bar{X})^2 \sum (Y_i - \bar{Y})^2}}
\]
1. Model design

1.6 GLM

Purpose of GLM

- Description of the risk structure by all relevant and available criteria including dependencies

- Selection of most relevant criteria (be aware of substitution; significant and systematic differentiation only)

- Quantify the relativities between different risk segments

- Check test results but never leave out practical hands-on view

- GLM enable simultaneous evaluation avoiding just adding up univariates
1. Model design

1.6 GLM: Why not simply multiplication of marginal values?

<table>
<thead>
<tr>
<th>Exp/BC</th>
<th>1</th>
<th>2</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>900/20,0</td>
<td>30/23,0</td>
<td>930/20,1</td>
</tr>
<tr>
<td>2</td>
<td>900/22,7</td>
<td>170/26,7</td>
<td>1070/23,3</td>
</tr>
<tr>
<td>total</td>
<td>1800/21,3</td>
<td>200/26,1</td>
<td>2000/21,8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Index</th>
<th>1</th>
<th>2</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>91,7</td>
<td>105,5</td>
<td>92,2</td>
</tr>
<tr>
<td>2</td>
<td>104,1</td>
<td>122,5</td>
<td>106,9</td>
</tr>
<tr>
<td>total</td>
<td>97,7</td>
<td>119,7</td>
<td>100,0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Index</th>
<th>1</th>
<th>2</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>90,1</td>
<td>110,4</td>
<td>92,2</td>
</tr>
<tr>
<td>2</td>
<td>104,4</td>
<td>128,0</td>
<td>106,9</td>
</tr>
<tr>
<td>total</td>
<td>97,7</td>
<td>119,7</td>
<td>100,0</td>
</tr>
</tbody>
</table>

Multiplying of the indexed values leads to:

This is obviously clearly deviating due to portfolio mix effects.
1. Model design

1.6 GLM: Why not simply multiplication of marginal values?

In this example we get by GLM for burning cost values (index in brackets, second = marginal value result, third = observed index):

\[ BC_{11} = 19,99 \ (91,6; \ 90,1; \ 91,7) \]
\[ BC_{12} = 23,43 \ (107,3; \ 110,4; \ 105,5) \]
\[ BC_{21} = 22,71 \ (104,1; \ 104,4; \ 104,1) \]
\[ BC_{22} = 26,62 \ (122,0; \ 128,0; \ 122,5) \]

This demonstrates a clearly better fit than multiplying marginal values.
1. Model design

1.6 GLM: Examples

MTPL PD frequency: take up of MOD

Model w/o Kasko take up: Inclusion in model could make sense
1. Model design

1.6 GLM: Examples

MTPL PD frequency: take up of MOD

Model with Kasko take up: differentiation by full comprehensive/fire&theft seems reasonable
1. Model design

1.6 GLM: Examples

MTPL PD frequency: take up of MOD

Model with Kasko take up: check of consistency over time
⇒ Full comprehensive and fire&theft take up only combined reasonable
this could not be detected by a test on the basis of aggregated data over time!
1. Model design

1.6 GLM: Examples

Theft of bikes: frequency

Model with age =>
Quite good regarding payment frequency: dependencies?
1. Model design

1.6 GLM: Examples

Distribution of payment frequency by age

Payment frequency: dependency with age
1. Model design

1.6 GLM: Examples

Private liability: age as a function?
1. Model design

1.6 GLM: Examples

Private liability: age modelled as polynomial
1. Model design

1.6 GLM: Examples

MOD glass frequency

Age of car modelled as function?

Age of car

Exposure

1-dim. relativities with curve

1-dim. relativities without curve
1. Model design

1.6 GLM: Examples

MOD glass frequency: age of car by year

Age of car as function: Impact of technical check up every two years starting after three years => not adequate
1. Model design

1.6 GLM: Examples

Interaction: annual payment by bank account similar to annual payment via direct debit, but monthly payment by bank account significantly worse than monthly payment via direct debit.
1. Model design

1.7 Lifetime value

Calculate the value/contribution of a policy or segment taking into account

- Average lifetime of a policy in the portfolio or measure of the annual canc x rate

- Loss ratio incl future development as future rate changes and claims inflation

- All expenses assigned to a policy especially commission

- Application of a suitable discount rate
## 1. Model design

### 1.7 Lifetime value

**Example**

<table>
<thead>
<tr>
<th>Years</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Summe</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVP</td>
<td>500</td>
<td>509.90</td>
<td>520.00</td>
<td>530.30</td>
<td>540.80</td>
<td>551.50</td>
<td>562.43</td>
<td>573.56</td>
<td>584.92</td>
<td>596.50</td>
<td></td>
</tr>
<tr>
<td>Policies</td>
<td>10,000</td>
<td>9,000</td>
<td>8,100</td>
<td>7,290</td>
<td>6,561</td>
<td>5,905</td>
<td>5,314</td>
<td>4,783</td>
<td>4,305</td>
<td>3,874</td>
<td></td>
</tr>
<tr>
<td>Loss ratio</td>
<td>80%</td>
<td>79.22%</td>
<td>78.45%</td>
<td>77.69%</td>
<td>76.94%</td>
<td>76.19%</td>
<td>75.45%</td>
<td>74.72%</td>
<td>73.99%</td>
<td>73.28%</td>
<td></td>
</tr>
<tr>
<td>Canx rate</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Price adjustment</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td>Claims inflation</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Discount rate</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Acquisition costs</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Admin costs</td>
<td>6%</td>
<td>6%</td>
<td>6%</td>
<td>6%</td>
<td>6%</td>
<td>6%</td>
<td>6%</td>
<td>6%</td>
<td>6%</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>Result per policy</td>
<td>-30.00</td>
<td>75.35</td>
<td>80.84</td>
<td>86.48</td>
<td>92.27</td>
<td>98.22</td>
<td>104.32</td>
<td>110.59</td>
<td>117.02</td>
<td>123.62</td>
<td>858.71</td>
</tr>
<tr>
<td>Result total</td>
<td>-300,000.00</td>
<td>678,118.81</td>
<td>654,789.04</td>
<td>630,425.47</td>
<td>605,381.86</td>
<td>579,958.41</td>
<td>554,408.41</td>
<td>528,944.09</td>
<td>503,741.85</td>
<td>478,946.90</td>
<td>491,914.85</td>
</tr>
</tbody>
</table>
1. Model design

1.8 Principles on model selection and use of methods

- Plausible results, which especially means explainable

- Stable results

- no academic exercise, but do the reasonable!

- Check of requirements of a certain method (for example assumption of independence)

- As complicated as necessary, as simple as possible (avoidance of modelling 4-dim. interactions)

- Models are always only a mapping of reality, which implies not to handle model outcomes as a fetish
1. Model design

1.8 Principles on model selection and use of methods

Vaccine example
A= healing, A'=no healing; B=treatment, B'= no treatment; C= city, C'= rurality

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>B'</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>1/43</td>
<td>14/43</td>
</tr>
<tr>
<td>AC'</td>
<td>4/43</td>
<td>10/43</td>
</tr>
<tr>
<td>A'C</td>
<td>1/43</td>
<td>10/43</td>
</tr>
<tr>
<td>A'C'</td>
<td>1/43</td>
<td>2/43</td>
</tr>
</tbody>
</table>

P(A/B,C)=1/2<P(A/B',C)=7/12 and P(A/B,C')=4/5<P(A/B',C')=5/6 but:
P(A/B)=5/7>P(A/B')=2/3

Hint: \[ P(A|B) = \frac{P(A \cap B)}{P(B)} \]
1. Model design

1.9 Internal and external framework
The actuarial department has as an integrated part of the processes in an insurance different interfaces to other departments:

- Reinsurance (gross/net evaluation)

- Claims handling/reserving (speed of claims development, judgement of necessary single case reserves; claims handling in general)

- Risk management/Financial Controlling (Premium/Reserve risk as substantial part of the company risk, monitoring of tariff performance)

- Accounting (different accounting systems with some specific rules like CER)

- Controlling (processes)

- IT (implementation of tariffs, data in general incl accessibility)

- Sales/Marketing (volume vs. profit)
1. Model design

1.9 Internal and external framework

- Statistical: data format, data accessibility (for example emergence of data), customer declaration (soft criteria), IT technology, software, internet based data (Big Data?)

- Legal: insurance regulation act, insurance contract act, equal treatment law (potential restriction on tariff criteria), Motor TPL obligation, regulation (Solvency II), insurance tax, competition law, data protection law, Money laundering/Financing terrorism, Anti bribery law

- Economical: fuel prices (impact on mileage), economical development in general (new car sales, mileage, building activity), insurance cycles, competition (car manufacturer selling insurance), impact of crisis, level of interest rates

- Political: German reunification, extension of EU (easier access due to open frontier), Corporate Social Responsibility, Sanctions/ Embargos
1. Model design

1.9 Internal and external framework

- Customer: mentality (affinity to internet sales? Increase of readiness to switch to another insurance); attitude to risk and to insurance, view on data protection (see telematics), internet behaviour in general

- Institutions: supervisor (Solvency II, see EU level as well), insurance associations, statistical authorities, supervisor of mergers and competition etc

- Products: terms and conditions; demand, acceptance/understandability

- Company strategy: orientation of products/rates to target segments, combined products (for example homeowner)

- External impacts: NatCat, weather trends; used materials (water pipes in buildings), technological developments (car, eCall, telematics, safety, protection against loss of heat in houses)
1. Model design

1.9 Internal and external framework

- IT/System
- Nature
- Customer
- Technology
- Target volume/profit
- Risk model
- Market/Competition
- Economy
- Legislation/Regulation
- Public perception

Tariff
2. Case study: Annual Mileage and BMS in German Motor Pricing

1. Pushed by J. Lemaire’s talk ASTIN 2013/Deregulation in EU as starting point
2. Introduction of mileage on company level
3. Becoming part of the GDV* recommendation
4. Stability and checks in comparison to other criteria incl market overview
5. Being part of a GLM model (company as well as market level)
6. Brief description of BMS (Bonus-Malus-System)
7. Interaction of annual mileage with other criteria especially BMS
8. Ranking of most important criteria: annual mileage being TOP 4 but not No 1
9. Outlook/Telematics
   *German association of insurances
During ASTIN 2013 J. Lemaire held a talk on annual mileage for motor pricing in USA and Taiwan and referred to some issues

1. So far mileage wasn’t really in use due to manipulation/false reporting
2. On the other hand mileage turned out as the most important dimension
3. As in huge literature the BMS models were built separately from other criteria a double counting potential came up

Therefore I thought it could be worthwhile to demonstrate the German experience
1. Pushed by J. Lemaire´s talk ASTIN 2013/Deregulation in EU as starting point

Motor tariff structure before deregulation in 1994:

1. BMS (22 classes)
2. Engine power in TPL* (12 classes)/type class in full comprehensive and fire+theft (31 classes each)
3. Territory (depending on big cities/rural areas and governmental employee yes/no)
4. Occupation (3 classes)

All this was part of a central recommendation provided by the German insurance association (GDV) in close relationship with the regulator (especially for TPL; background is the legal obligation to get a TPL insurance, otherwise you can´t register the car and on the other hand insurances are obliged to offer TPL insurance).
This was done as sort of a GLM.

*Third Party Liability
2. Introduction on company level

Motor tariff structure after deregulation in 1994 with new criteria:

1. Mileage
2. Houseownership
3. Parking location
4. Refined territory
5. Type class also for TPL
6. Extended BMS (29 classes, currently 39)
7. Age
8. Age of car
9. Age of car at purchase
10. Occupation (refined)
11. Payment
12. Sex (since Dec 2012 not more legal)
13. User of the car
14. ...

The central recommendation provided by the German insurance association (GDV) still existed but all add-ons where on company level

More possible tariff cells than cars in Germany!
3. Becoming part of the GDV recommendation

Motor tariff structure after deregulation in 1994 with new criteria:

1. Driven by (new) possibilities of competition

2. Many other criteria were tried and checked like use of public transport

3. On the central GDV level also new structures were started: type class instead of engine power for TPL which was and is centrally managed on the basis of officially available information about all car types (classification of all car types by burning cost index taking other dimensions into account), refinement of regional level, extension of BMS to 29 classes

4. For the first time an UW cycle (rates went down; overall a reduction of 10% of premium) occurred as an indication for significantly increased competition

5. As competition went on the process of alignment of tariff structures came up to avoid negative selection issues

6. As a consequence the first two new criteria entered the central recommendation (no longer a competitive advantage for a company): parking location and mileage
3. Becoming part of the GDV recommendation

Motor tariff structure after deregulation in 1994 with new criteria:

1. Currently this process is mainly done resulting in significantly more tariff dimensions than before 1994 also involving more potential interactions

2. Almost all criteria are part of the central recommendation and BMS was extended further to 39 classes

3. Each company is free to use this recommendation or deviate from it partly or completely

4. On GDV as well as on company level the evaluation of the tariff is subject to GLM (some details see below)
4. Stability and checks in comparison to other criteria incl. market overview

Some background information on the German motor insurance market to highlight/detail what was/is going on with certain tariff dimensions:

1. Still more than 70% of the business are done by (classical) tied agents/brokers.
2. After 1994 some direct insurers started but were coming up significantly slower than forecasted and in other countries.
3. Also the customer behaviour was changing slower: aggregators are clearly growing but still on a lower level than in other countries.
4. In peoples minds data protection is a bigger issue than for example in the UK which had/has an impact on the very reluctant introduction of telematic based tariffs.
5. Since 1994 we faced two rounds of the UW cycle which were seriously oscillating between 20 bln€ and 25 bln€ premium by something like 20%. Due to low interest rates the cycle seems currently a bit out of order.
6. Split of the German motor market and further information: see next slides
7. Policies have to be actively cancelled if customers want to switch to another insurance (automatic renewal).
8. Pricing is split by tariff generation within BoB* and especially between NB* and BoB

Summing up: The Germans seem to be rather conservative but the market also very competitive.

*BoB: book of business, NB: new business
How was the topline development of motor insurance within the last decade?

4. Stability and checks in comparison to other criteria incl. market overview

Motor insurance GWP in bln. €

Source: GDV

Future expectations: 2017: +4,0%
4. Stability and checks in comparison to other criteria incl. market overview

Competitive environment 2016: 90 motor insurers

5 companies
8.7 bln. € GWP
34% market share

12 companies
8.7 bln. € GWP
34% market share

73 companies
8.5 bln. € GWP
32% market share

90 companies
25.9 bln. € GWP
Sales channel split for motor insurance new business

Source: „Anteile der Vertriebswege am Beitragsaufkommen“; published by GDV yearly
Let’s look at parking location and mileage in the recent years:

1. Meanwhile parking location lost all distinctive power whereas mileage is still on the same (high) level of differentiation as it started. Why?

2. Both criteria are depending on what the customer is saying.

3. But mileage is subject to potential checks: Customer are asked to tell their current mileage status which could be repeated later on and also in case of a claim to keep people away from lying.

4. If there is a „shift due to lies“ let’s say for one class only the name of the class is wrong, the differentiation stays ok.

5. Since Diesel fuel is cheaper than other fuel types but tax for Diesel cars is higher Diesel only makes sense when driving quite a lot which enables also a check/mistrust in case a Diesel car is said to have a low mileage (average mileage in Germany is between 15,000 and 20,000 km).

Summing up: The Germans seem to tell mainly the truth about their mileage.
4. Stability and checks in comparison to other criteria incl market overview

Let’s look at parking location and mileage in the recent years:

1. Currently 75% of the people are saying that they own a garage to park their car which can’t be true.

2. Therefore there might be quite a lot who do not park their car in a garage but saying this and consequently the distinction was shifted from yes/no to yes/mixture of yes and no and could mostly be neglected.

3. Background: Compared to their (rather) new direct competitors traditional tied agent insurers are located in the high rate area; therefore some 5%-discount for a garage could help out to keep the customer.

4. So a „flexible“ understanding of garage is an advantage for the tied agent who on the other hand might be the control level for customers of having a garage (this is valid for brokers as well, also face to face sale).

5. Therefore the increased occurrence of garages might be mainly not driven from the customer or at least provides pricewise/persistency advantages for both sides involved in making the insurance contract.

Summing up: The distinction of this vanished due to an implicit agreement on advantages for the customer and the tied agent/broker.
5. Being part of a GLM model (company as well as market level)

Let's look at tariff dimensions in use:

1. Criteria used by GDV in TPL (see brief description of providing BMS by GDV below; number of classes in brackets): BMS (39), type class (16), regional class (12), mileage (8), occupation (3), flat/house ownership (2), user (2), age of user (16), car age at purchase (12) => above 23m possible tariff cells

2. Further criteria used by companies: car age, time of owning a car, young driver, payment frequency, payment mode, marital status, time of having a driving license => more tariff cells than cars
Description GDV-Bonus/Malus-System

- Relativities/factors in terms of percentages (relative to a reference class) on the basis of market data with certain smoothing (GLM: Poisson distribution with log-link, different dimensions): in earlier time mainly by dividing burning costs for class x and class 1; now different (see below)

- Definition of downgrading in case of a claim with separate data due to more complex data needed: NCD* class from previous year and individual claim number in previous year (same GLM as above; see table below; now with some smoothing by regression)

- GDV model avoids disadvantage of non-entire frequencies on policy level (non-annual policies for example in case of car replacements) which one has to face if using a simple claim number distribution like the Poisson-Gamma approach which can be seen as a Bühlmann credibility model but using the Bühlmann/ Straub model enables the inclusion of weights GDV model also uses further dimensions which is a disadvantage of the simple Poisson-Gamma approach but this can also be avoided (see below)

- For all models (that is a general problem) a matrix of relativities would be more appropriate; reduction to a vector which is the practice implies some inhomogeneity

*NCD: no claims discount
6. Brief description of BMS: comparison old/new (recent extension) TPL factors, percentages, reference class (blue underlying)

<table>
<thead>
<tr>
<th>NCD classes</th>
<th>Portfolio distribution</th>
<th>Relativities/factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>old</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF 12</td>
<td>654.211,3</td>
<td>4.37</td>
</tr>
<tr>
<td>SF 1</td>
<td>731.547,3</td>
<td>4.67</td>
</tr>
<tr>
<td>SF 2</td>
<td>706.350,9</td>
<td>4.71</td>
</tr>
<tr>
<td>SF 3</td>
<td>743.054,3</td>
<td>4.74</td>
</tr>
<tr>
<td>SF 4</td>
<td>703.108,9</td>
<td>4.49</td>
</tr>
<tr>
<td>SF 5</td>
<td>706.708,7</td>
<td>4.51</td>
</tr>
<tr>
<td>SF 6</td>
<td>712.517,4</td>
<td>4.59</td>
</tr>
<tr>
<td>SF 7</td>
<td>710.477,1</td>
<td>4.64</td>
</tr>
<tr>
<td>SF 8</td>
<td>679.374,4</td>
<td>4.33</td>
</tr>
<tr>
<td>SF 9</td>
<td>761.591,4</td>
<td>4.86</td>
</tr>
<tr>
<td>SF 10</td>
<td>764.530,5</td>
<td>4.88</td>
</tr>
<tr>
<td>SF 11</td>
<td>613.166,0</td>
<td>3.92</td>
</tr>
<tr>
<td>SF 12</td>
<td>542.042,5</td>
<td>3.48</td>
</tr>
<tr>
<td>SF 13</td>
<td>517.614,3</td>
<td>3.31</td>
</tr>
<tr>
<td>SF 14</td>
<td>566.533,7</td>
<td>3.64</td>
</tr>
<tr>
<td>SF 15</td>
<td>503.183,9</td>
<td>3.44</td>
</tr>
<tr>
<td>SF 16</td>
<td>435.829,3</td>
<td>2.78</td>
</tr>
<tr>
<td>SF 17</td>
<td>454.718,0</td>
<td>2.90</td>
</tr>
<tr>
<td>SF 18</td>
<td>389.710,9</td>
<td>2.49</td>
</tr>
<tr>
<td>SF 19</td>
<td>377.456,8</td>
<td>2.41</td>
</tr>
<tr>
<td>SF 20</td>
<td>388.357,3</td>
<td>2.35</td>
</tr>
<tr>
<td>SF 21</td>
<td>241.176,4</td>
<td>1.54</td>
</tr>
<tr>
<td>SF 22</td>
<td>210.691,3</td>
<td>1.35</td>
</tr>
<tr>
<td>SF 23</td>
<td>205.125,7</td>
<td>1.31</td>
</tr>
<tr>
<td>SF 24</td>
<td>144.051,2</td>
<td>0.92</td>
</tr>
<tr>
<td>Gesamt</td>
<td>15.690.153,2</td>
<td>100</td>
</tr>
</tbody>
</table>

New best percentage higher than old best percentage: Difficult to communicate towards customer (background: more dimensions taken into account), issue is solved by change of reference class to class 0 and/or change of setting reference class percentage from 100 to a lower value

| SF 1 | 1.747.270 | 1.7 | 1.7937 | 426 | 219 | 274 |
| SF 2 | 2.687.160 | 2.7 | 1.6462 | 302 | 142 | 195 |
| SF 3 | 2.957.755 | 3.0 | 1.5318 | 271 | 135 | 171 |
| SF 4 | 3.394.783 | 3.4 | 1.4351 | 254 | 127 | 160 |
| SF 5 | 3.616.968 | 3.6 | 1.3523 | 244 | 122 | 158 |
| SF 6 | 3.745.247 | 3.8 | 1.2806 | 239 | 121 | 156 |
| SF 7 | 3.751.748 | 3.8 | 1.2179 | 239 | 121 | 156 |
| SF 8 | 3.658.843 | 3.7 | 1.1336 | 238 | 120 | 155 |
| SF 9 | 3.838.923 | 3.9 | 1.0697 | 237 | 120 | 155 |
| SF 10 | 3.594.142 | 4.0 | 1.0302 | 237 | 120 | 155 |
| SF 11 | 3.583.514 | 3.6 | 0.9945 | 237 | 120 | 155 |
| SF 12 | 3.882.024 | 3.4 | 0.9620 | 237 | 120 | 155 |
| SF 13 | 3.882.024 | 3.4 | 0.9620 | 237 | 120 | 155 |
| SF 14 | 3.882.024 | 3.4 | 0.9620 | 237 | 120 | 155 |
| SF 15 | 3.026.702 | 3.0 | 0.9053 | 237 | 120 | 155 |
| SF 16 | 2.874.794 | 2.9 | 0.8803 | 237 | 120 | 155 |
| SF 17 | 2.716.363 | 2.7 | 0.8573 | 237 | 120 | 155 |
| SF 18 | 2.666.924 | 2.7 | 0.8360 | 237 | 120 | 155 |
| SF 19 | 2.623.452 | 2.6 | 0.8162 | 237 | 120 | 155 |
| SF 20 | 2.698.067 | 2.6 | 0.7979 | 237 | 120 | 155 |
| SF 21 | 2.515.485 | 2.5 | 0.7806 | 237 | 120 | 155 |
| SF 22 | 2.305.915 | 3.0 | 0.7645 | 237 | 120 | 155 |
| SF 23 | 2.960.610 | 3.0 | 0.7494 | 237 | 120 | 155 |
| SF 24 | 2.782.912 | 2.8 | 0.7353 | 237 | 120 | 155 |
| SF 25 | 2.557.335 | 2.6 | 0.7219 | 237 | 120 | 155 |
| SF 26 | 2.380.773 | 2.4 | 0.7094 | 237 | 120 | 155 |
| SF 27 | 2.300.293 | 2.3 | 0.6975 | 237 | 120 | 155 |
| SF 28 | 2.149.080 | 2.2 | 0.6863 | 237 | 120 | 155 |
| SF 29 | 1.926.993 | 1.9 | 0.6757 | 237 | 120 | 155 |
| SF 30 | 1.663.672 | 2.1 | 0.6546 | 237 | 120 | 155 |
| SF 31 | 1.339.134 | 1.3 | 0.6560 | 237 | 120 | 155 |
| SF 32 | 1.290.774 | 1.3 | 0.6469 | 237 | 120 | 155 |
| SF 33 | 1.057.201 | 1.1 | 0.6383 | 237 | 120 | 155 |
| SF 34 | 896.098 | 0.9 | 0.6300 | 237 | 120 | 155 |
| SF 35 | 5.089.021 | 5.1 | 0.5842 | 237 | 120 | 155 |

Confidence intervals

Factors relative to reference class (deliberate choice)
6. Brief description of BMS: comparison old/new TPL downgrade

For example:
1 claim in NCD 25 gives downgrade to NCD 11 (old) and NCD12 (new)
## 6. Brief description of BMS: principle definition of downgrade

Evaluation of GDV downgrade for full comprehensive (original process: now with smoothing by regression, same principle also for TPL); constant downgrade in multiplicative sense due to claim number of previous year as independent dimension.

### 6.1 Burning costs current year by NCD class previous year and claim number previous year (0, 1 or 2)

<table>
<thead>
<tr>
<th>NCD class previous year</th>
<th>Claim number previous year</th>
<th>Burning costs current year</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>1,043</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>971</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
<td>846</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>708</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>617</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>569</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>473</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>418</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>360</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>323</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>275</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>226</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
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<td>6</td>
<td>0</td>
<td>294</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>249</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>205</td>
</tr>
</tbody>
</table>

- **Example:**
  - NCD 25 in previous year with 1 claim in previous year has burning cost of 189;
  - next to this value is NCD 20 w/o claim in previous year with burning cost of 186 => resulting rule: downgrade for 1 claim from NCD 25 to NCD 20

factor = 1.35
6. Brief description of BMS: principle definition of downgrade

Rule for downgrade definition: From a burning cost value of a certain NCD class with claim previous year (blue curve) go left until hitting the red curve (description above), then go down to find the NCD class belonging to that value (see example in the graph above): alignment of risks with claim to claim free risks with same burning cost
Let’s look at interactions:

1. On GDV level with type class (currently not any more)
2. No interaction with BMS*
3. On distribution or mix side with gender (partial substitution in unisex case): women drive less than men
4. Interaction with fuel type: Higher mileage for Diesel cars
5. Interactions to be checked and identified during GLM evaluation process

Summing up: Overseeable interactions without problems for pricing

* Both being part of a GLM but even in case of using Poisson-Gamma for BMS and GLM for other criteria one can avoid double counting: Poisson-Gamma could be seen as credibility model which can be combined with GLM to one single algorithm (see E. Ohlsson/B. Johansson: Non-Life Insurance Pricing with Generalized Linear Models, 2010)
8. Ranking of most important criteria: annual mileage being TOP 4 but not No 1

Let’s look at distinctive power of the most important tariff dimensions for TPL (in terms of multiplicative distance between minimal and maximal factor):

1. Type class: distance = 8.68
2. BMS: distance = 6.77
3. Age of user: distance = 2.63
4. Mileage: distance = 1.69

(GDV level)
9. Outlook/Telematics

1. Mileage with stable outlook in terms of distinctive power

2. Compared to other European countries telematic is mainly not in use for pricing

3. Telematic devices are used for offering assistance; eCall (emergency call) will be obligatory by EU in near future for new car types (not new cars)

4. There was a telematic pilot for young drivers brought to the market by one company but did not go life at the end (technical issues?) A recent pilot generates more criticism in the public than positive feedback

5. Given the existing range of differentiation in motor tariffs you could expect that there might be only small differences in rates (normal vs telematic) for something like 75% of the risks; this should be different for high risk areas like young drivers or luxury cars (theft).

6. Data protection is a bigger issue in Germany than in other countries („glass clear car driver“).

Summing up: The distinction of mileage will stay; mileage would be also important for telematic based pricing but this is not yet started.
Muchas gracias por su atencion! Many thanks for your attention! Preguntas? Questions?

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