

Workshop Pricing ASTIN Cape Town 2019

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DAA

DEUTSCHE
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Definition

Tariff (arabian) = Price list

TARIFF = Price system for an insurance product
= adequate alignment of average claims amount to the risk in the underlying collective (equivalence principle), especially taking into account systematic deviations between risks by differentiation of the price by using suitable criteria

=> Price is a central element of insurance business
(Product -> Sales -> Customer)

Description of relevant elements, work flow and methods of pricing
(mass products; not reinsurance)

Here we are dealing less with mathematics but essentially with practice and application.

Agenda

1. Sourcing and processing of data
2. Model design
3. Case study

1. Sourcing and processing of data

1.1 Data source

1.2 Measuring exposure/portfolio size

1.3 Mapping of premium and claims

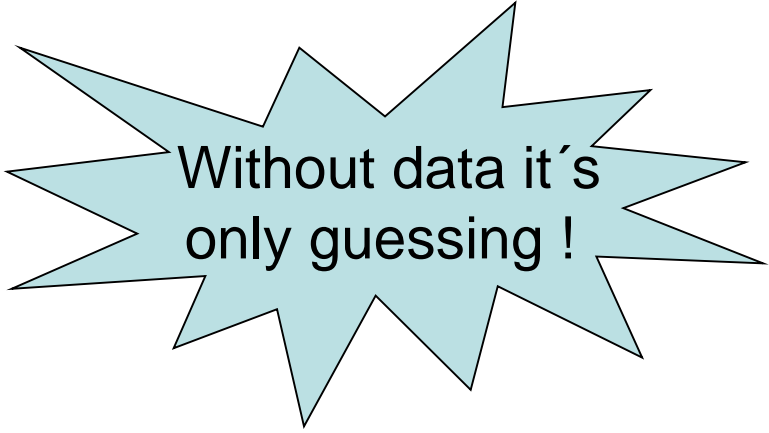
1.4 Derived KPIs

1.5 Type of claims and large claims

1.6 Significance of statistics/evaluations and required portfolio size

1.7 Actuarial Controlling-Cycle

1.8 Data check and verification



Without data it's
only guessing !

1. Sourcing and processing of data

1.1 Data source

be especially aware: nature of the data and their collection with respect to their assignment to a specified use

- Internal sources (ideally accessible promptly and contentwise): specific LoB of the insurance; other LoB of the insurance; on group level available data

Examples: tariff criteria, premiums/exposure, payment and address data, sales related data (separation by point of sale), calls, conversion, reasons for canx, allocation of marketing adspend, claims data (payments, provisions, type of claims, claims handling), expenses (general/admin, acquisition)

1. Sourcing and processing of data

1.1 Data source

- External sources (only by involvement of third parties producible and applicable): Market or partial market data out of pooling data like insurers association, reinsurer, software provider (in Germany motor insurance prices)

Type of data: regarding content and format often similar to company data which are normally included

National Authority for statistics or traffic, provider for car prices, NatCat-Models etc

Type of data (to be bought when indicated): population development, salary/price index, new vehicle registration, vehicle data, car prices, social and demographic data (partially down to single house level), lightning data etc

1. Sourcing and processing of data

1.1 Data source

- Internet based data to characterise group of persons/behaviour (for example allocation of online adspend)

Recommendation: detailed cost/benefit analysis

1. Sourcing and processing of data

1.2 Measuring exposure/portfolio size

- booked and earned premium (AVP*; accident year view)
- Number of policies (canx analysis, also an application of GLM)
- Earned vehicle years = EVY (risk evaluation, see also GLM)
- Sum insured (value of buildings, household content etc)

*average premium

1. Sourcing and processing of data

1.2 Measuring exposure/portfolio size

- booked and earned premium: for example yearly premium paid per July 1st fully counted as booked but only half as earned
- Number of policies: important for canx
- EVY: exact measure of exposure not only for motor (for example exact by day: number of insured days within a year/360), but no smooth frequency on policy level (1 claim in 70 days => freq = 5,143 vs 1 claim in a year => freq = 1); change of the policy throughout the year (see car replacement)
- Sum insured: for value based products like houses etc; up to inflation!

1. Sourcing and processing of data

1.3 Mapping of premiums and claims

- Reporting year: reported during the calendar year (independent from occurrence date), for example marketwide statistics (at the end of the year you lose some IBNR amount which you get as a similar amount from previous year)
- Accident year: alignment by occurrence date, important for analysis of reserve position

1. Sourcing and processing of data

1.3 Mapping of premiums and claims

- Reporting year: in the German motor insurance market you have roughly 10% IBNR claims; for strongly growing portfolios the assumption of such a fixed amount of IBNR would lead to an underestimation of the claims amount of a reporting year; reserves are fixed by end of the year without taking into account later changes; this implies steering possibilities for reserves with result implications
- Accident year: alignment by occurrence date allows for judgement of adequacy of reserves (claims development analysis!), loss ratios enable to check sufficiency of earned premiums to cover claims amount

1. Sourcing and processing of data

1.4 Derived KPIs

- Frequency = claims count/exposure
- Average claims cost = claims amount/claims count
- Burning cost = claims amount/exposure

1. Sourcing and processing of data

1.5 Type of claims

- TPL (motor and general): bodily injury, property damage, financial damage
MOD: collision, theft, glass, NatCat, collision with game, marten bite, fire
- buildings/household content: fire, burst of water pipes, windstorm, theft, different inclusions (bikes, lightning/overvoltage)
- Characteristics: long claims development for BI, IBNR (for example TPL for architects, oil tanks), equalisation only in the long run for NatCat, climate change, fraud potential overvoltage, construction standards for waterpipes, inclusions only if high probability of realising risk

1. Sourcing and processing of data

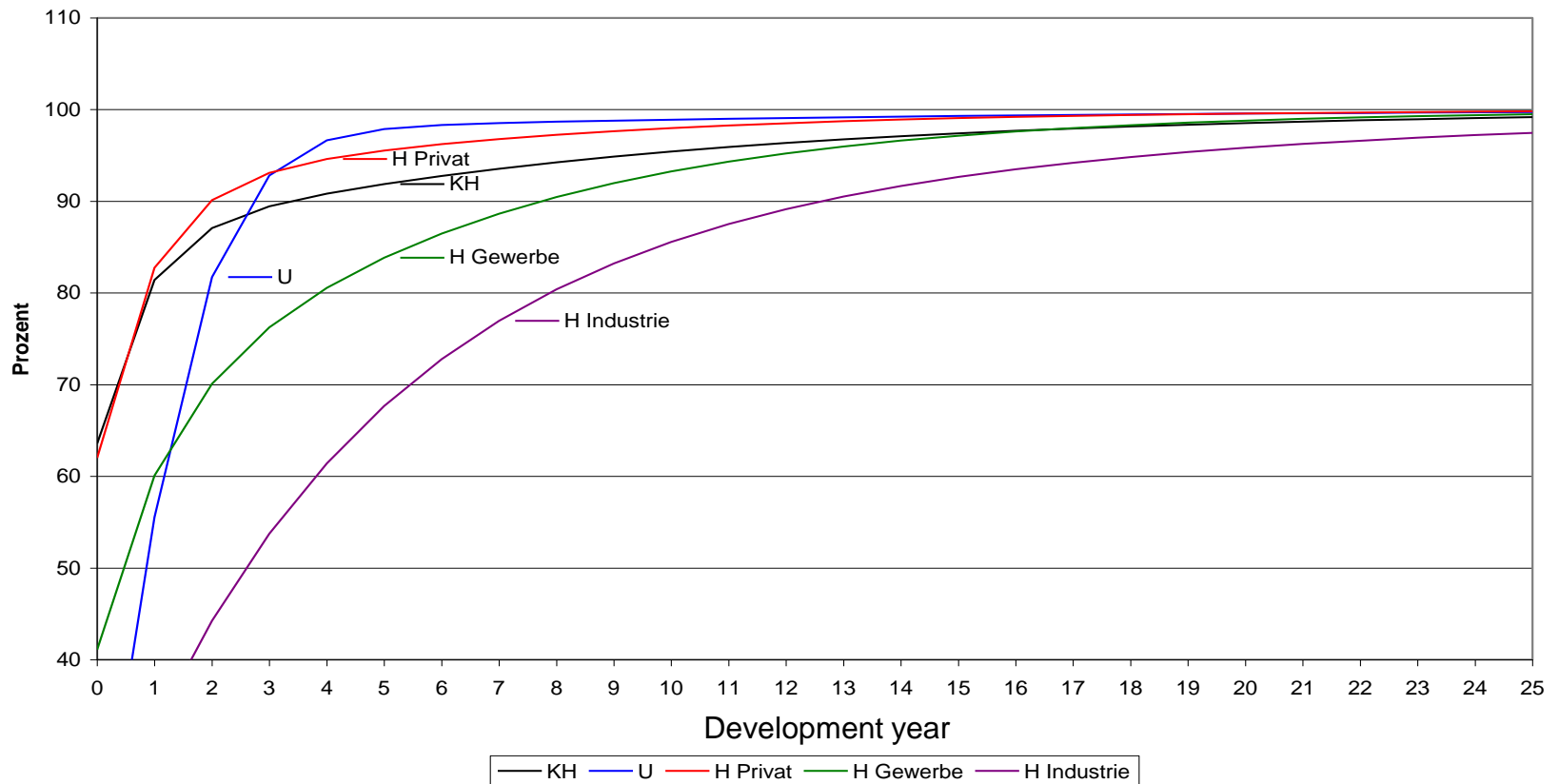
1.5 Large claims and NatCat claims

- MTPL: pension case claim open for decades, very high amount possible for single claim (up to 100 m€, damage of motorway bridge for example)
- NatCat: high volatility year by year, partly very local (hail), up to billions of claims amount (Munich hail 1984, hail storm Andreas 2013: each second cost 7 m€)

Potential impact: randomly caused bias; large claims are typical for MTPL but not for each segment (exception young driver with higher probability for BI claims) => adjustment/cut off to keep random out and identify systematic differentiation only

1. Sourcing and processing of data

Cumulative payout pattern



1. Sourcing and processing of data

1.5 Definition large claim

- Tschebychev inequality (rough, but robust method)
- Reduction coefficient of variation (look for a cut off point where clear reduction changed to flat area; usual coefficient of variation of burning cost for a single MTPL risk clearly double digit number which remains only half of that by suitable cut off)
- Fit of distribution with different cut off points (for example Pareto, LogNormal; consider data volume vs reasonable definition of large claim)
- Hill-estimator to determine a extreme value distribution (Characterisation of a asymptotic type of distribution)
- Inequality of Cantelli:

$$P(X - E(X) \geq \varepsilon) \leq \frac{VarX}{\varepsilon^2 + VarX}$$

1. Sourcing and processing of data

1.5 Definition large claim

- Tschebychev inequality:
$$P(|X - \mu| \geq k \cdot \sigma) \leq \frac{1}{k^2}$$

The probability that the claims amount differs from the expected average claim more than k times of the standard deviation is max at $1/k^2$

So for $k=10$ maximal 1% of the claims were cut off.

If we know the distribution of the claims amount then we see that this is a rough estimation; for a Pareto distribution with parameter 3 the real share of those claims is below 0,1%

1. Sourcing and processing of data

1.6 Informational value of statistics

- Deductibles/coverage sums: claims stay as a whole or partly outside the data; possible choice of the customer; therefore in case of a new deductible evaluation of the premium reduction not only on a pure number basis (size range statistics): selection effects due to customer choice and his risk appetite
- Claim specific inflation: garage costs (salary and parts); medical costs; adjustment with suitable indexing
- Claims development: volatility of development, adequacy of reserves (differences by claim size; superimposed inflation)
- Sufficient data volume as basis for reliable conclusions (cut off for large claims, minimum requirements for sample size as an orientation [eventually valid results also for few data possible, see young driver])

1. Sourcing and processing of data

1.6 Informational value of statistics: Introduction of a deductible

Which deductible is reasonable?

Range of claim size	Claim number	amount	Priority
Up to 100€	2,500	125,000	1,775,000
above 100 up to 500€	3,500	1,225,000	7,850,000
above 500 up to 1,000€	6,000	5,000,000	13,350,000
above 1,000€	7,000	14,150,000	20,500,000
total	19,000	20,500,000	20,500,000

Example: first priority = $125,000 + (19,000 - 2,500) * 100$

Maximal reduction of claims amount:

Deductible 100: 8.7% => too low in terms of price reduction

Deductible 500: 38.3% reasonable

Deductible 1,000: 65.1% => too much risk transfer to the customer

1. Sourcing and processing of data

1.6 Informational value of statistics: Introduction of a deductible

Assume that this portfolio is split into two homogenous risk groups

1	#risks	#claims	Claims amount	CF	ACC	BC
	50,000	12,000	8,600,000	24%	717	172

2	#risks	#claims	Claims amount	CF	ACC	BC
	50,000	7,000	11,900,000	14%	1700	238

Characterisation:

Risk group 1: more frequent but smaller claims

Risk group 2: less frequent but more severe claims

=> Choice of deductible (500€) more often in risk group 1 (2): higher (lower) reduction of claims amount in comparison to overall view

1. Sourcing and processing of data

1.6 Informational value of statistics: Introduction of a deductible

Distribution of claim size for these risk groups

1

Range of claim size	#claims	Claims amount	Priority
Up to 100€	2,000	100,000	1,100,000
above 100 up to 500€	2,000	700,000	4,800,000
above 500 up to 1,000€	4,000	3,000,000	7,800,000
above 1,000€	4,000	4,800,000	8,600,000
total	12,000	8,600,000	8,600,000

2

Range of claim size	#claims	Claims amount	Priority
Up to 100€	500	25,000	675,000
above 100 up to 500€	1,500	525,000	3,050,000
above 500 up to 1,000€	2,000	2,000,000	5,550,000
above 1,000€	3,000	9,350,000	11,900,000
total	7,000	11,900,000	11,900,000

Maximal reduction of claims amount for deductible of 500€

Risk group 1: 55.8% and Risk group 2: 25.6%

=> Significant difference to overall value of 38.3% and consequently the overall realised reduction of claims amount relies clearly on the choice of the deductible by the risk groups; therefore the initial price reduction for this deductible should be less than 38.3%

1. Sourcing and processing of data

1.6 Evaluation of minimum requirement on sample size

Theoretical foundation: compound Poisson distribution for the total claims amount

$$S = X_1 + X_2 + \dots + X_N$$

of a collective of risks with N =rv claims count, X_i for the size of the i -th claim (iid), N independent as well.

Set n as the risk count, so you get for the target figure burning cost the following for expected value and variance of the burning cost distribution for the single risk of the underlying collective

$$E(BC) = \mu = (E(N) / n) \cdot E(X)$$

$$Var(BC) = \sigma^2 / n = (E(N) / n) \cdot E(X^2) \cdot \frac{1}{n}$$

1. Sourcing and processing of data

1.6 Evaluation of minimum requirement on sample size

Using approximation with normal distribution for S (-> CLT) one can assume that

$$\sqrt{n} \cdot \frac{BC - \mu}{\sigma}$$

is approximately standard-normal distributed.

Reliability of burning cost means that the realisation of BC is not too far off from its expected value.

To quantify we need a significance level $1-\alpha$ (usually 0,95), so that the probability that the maximal tolerated relative deviation of BC from its expected value is max ε (for example 5%), asymptotically is at $1-\alpha$.

1. Sourcing and processing of data

1.6 Evaluation of minimum requirement on sample size

So we get

$$P\left(\sqrt{n} \cdot \frac{|BC - \mu|}{\sigma} \leq u_{1-\frac{\alpha}{2}}\right) \xrightarrow{n \rightarrow \infty} 1 - \alpha$$

with the two-sided quantile of the standard-normal distribution for the specified level of significance

The term in the brackets can be rewritten as

$$\frac{|BC - \mu|}{\mu} \leq \frac{u_{1-\frac{\alpha}{2}}}{\sqrt{n}} \cdot \frac{\sigma}{\mu}$$

1. Sourcing and processing of data

1.6 Evaluation of minimum requirement on sample size

On the left we have the relative deviation. Therefore the right side has to be smaller than the maximal tolerated relative deviation.

So the required risk count must be above the right-hand threshold which is the minimum required sample size given the specified parameters for significance and deviation:

$$n \geq \frac{u_{1-\frac{\alpha}{2}}^2}{\varepsilon^2} \cdot \frac{\sigma^2}{\mu^2}$$

The ratio on the right will be estimated on the basis of all data (see compound Poisson model).

1. Sourcing and processing of data

1.6 Evaluation of minimum requirement on sample size

In the compound Poisson model we get for the estimation of the coefficient of variation with $FQ =$ estimated frequency of the single risk:

$$\frac{\sigma^2}{\mu^2} = \frac{n \cdot E(X^2)}{E(N) \cdot E^2(X)} = \frac{1}{FQ} \cdot (\text{Var}Ko^2(X) + 1)$$

So we can see that the coefficient of variation of the claim size has a clear impact or other way round that cutting off is able to reduce significantly the minimum required sample size.

Hint on expected value and variance in the general approach of collective model:

$$S = \sum_{i=1}^N X_i \Rightarrow E(S) = E(E(S|N)) = E(N \cdot E(X)) = E(N)E(X)$$

$$\text{Var}(S) = E(\text{Var}(S|N)) + \text{Var}(E(S|N)) = E(N)\text{Var}X + \text{Var}NE^2(X)$$

1. Sourcing and processing of data

1.6 Evaluation of minimum requirement on sample size

Example MTPL:

We assume $FQ = 0,07$
 $E(X) = 3,556$ (w/o cut off)
 and $VarKo(X) = 7.4$ (w/o cut off):

$$\frac{\sigma}{\mu} = \sqrt{\frac{1}{FQ} \cdot (VarKo^2(X) + 1)} = 28.2$$

with $E(X) = 3,200$ (cut off at 150,000€)
 $VarKo(X) = 2,7$ (cut off at 150,000€):

$$\frac{\sigma}{\mu} = \sqrt{\frac{1}{FQ} \cdot (VarKo^2(X) + 1)} = 10.9$$

This clearly demonstrates that cutting off reduces the variance more than the average.

1. Sourcing and processing of data

1.7 Actuarial Controlling-Cycle

- The need to raise new data in case of introduction of new products/
rating criteria
- Portfolios with new information are growing slowly => necessary to
act as early as possible
- Eventually reasonable to raise ongoing currently not relevant
information
- Recommendation: Check cost/benefit (for example on a yearly basis)
- Monitoring/Reporting of the tariff-performance (so frequent/realtime
as possible)

1. Sourcing and processing of data

1.8 Data check and verification (are the data adequate given the question?)

- Validity: compliance of a certain defined range of values
- Exactness (absolute, effective, relative): exact postcode, postcode sufficiently exact to make sure a mapping to a bigger unit with certain deviations
- Representativeness: sufficient and/or adequate structured data to be able to answer the questions being on the table
- Completeness: for example exact all claims of a certain year being recorded

1. Sourcing and processing of data

1.8 Data check and verification

- Documentation: data sources and how they were collected, content of the checks, eventually necessary changes of the data, questionable data/inconsistencies, estimation of the impact of incorrect/incomplete data

- Difference between categorial and numerical data

categorial: flat/house ownership, sex, age class

numerical: claim size, age

1. Sourcing and processing of data

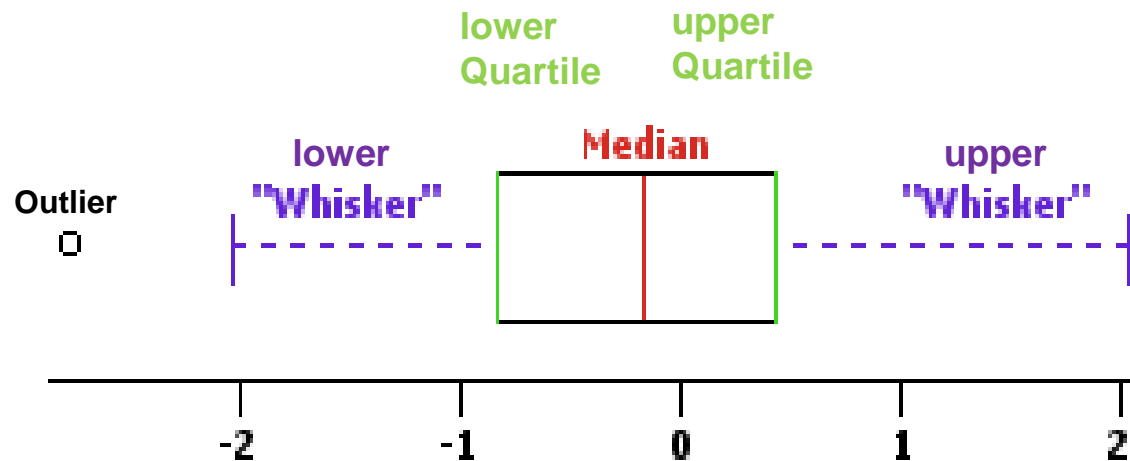
1.8 Data check and verification for numerical data

- Frequently: not plausible size of figures, missing data = 0 (potential outliers?)
- Histogram to check distribution of certain cluster/classes
- Comparison year on year
- Box-Plots: Demonstration of central tendency, variation, skewness
- Q-Q-Plots: Check the fit of a theoretical distribution

1. Sourcing and processing of data

1.8 Data check and verification

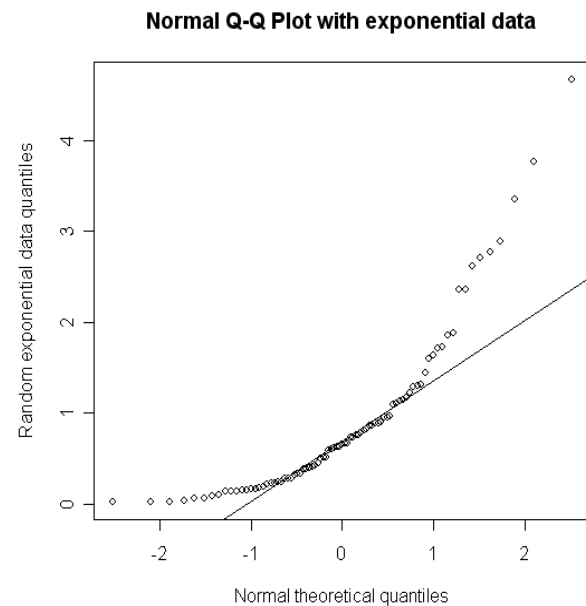
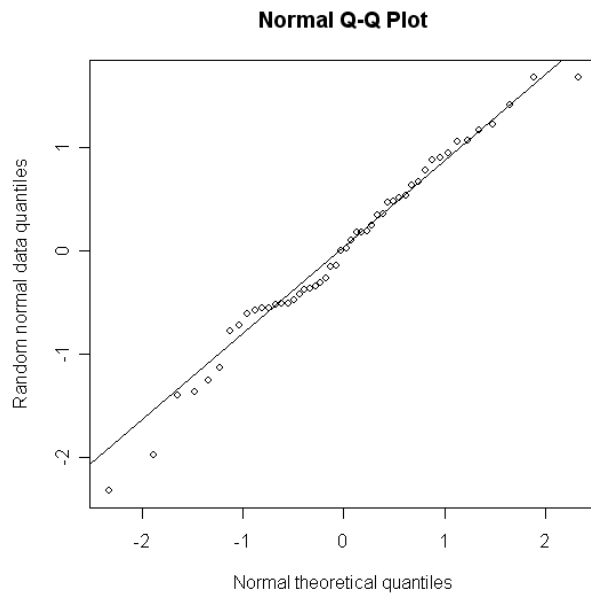
Box-Whisker-Plot



1. Sourcing and processing of data

1.8 Data check and verification

Q-Q-Plot



1. Sourcing and processing of data

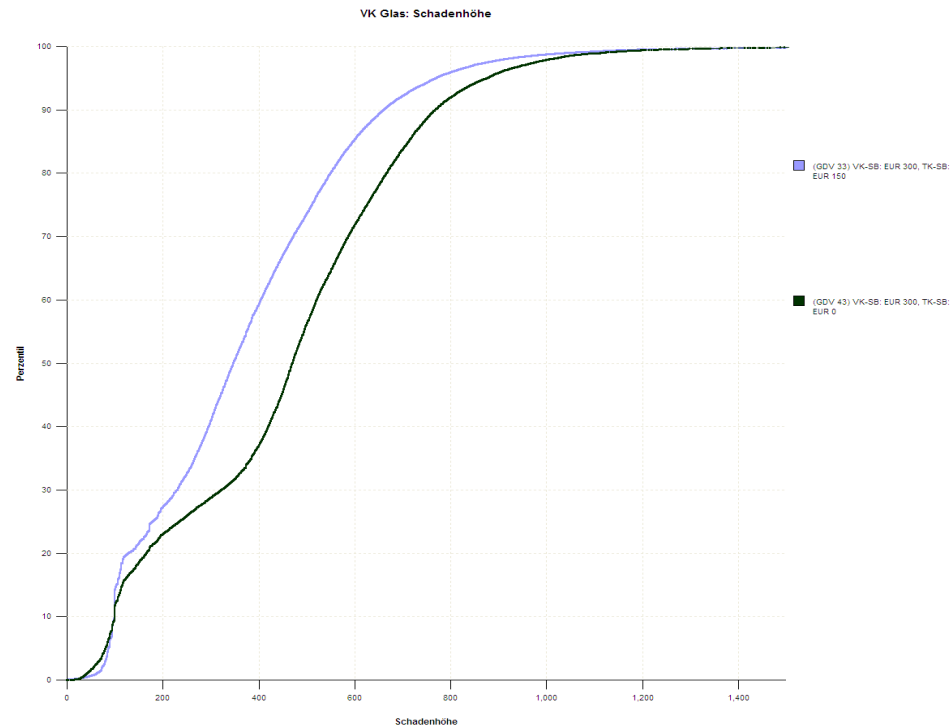
1.8 Data check and verification

- Size range statistics: distribution by claim size
- t-Test for deviation vs theoretical reference values
- Mahalanobis-distance: measure the distance to the center of the data
=> relevant for search for outliers
- BUT: in general hands-on procedure are a suitable and sufficient choice to check data

1. Sourcing and processing of data

1.8 Data check and verification: Example with surprise

Glass claim size distribution
Full Comprehensive for
deductible 0 and 150€



1. Sourcing and processing of data

1.8 Data check and verification for categorical data

- Check for formal correctness: allowed values
- Check of portfolio distribution (timewise, year on year or with market data)
- Check of KPIs like frequency (for example decreasing by NCD class?)

These are onedimensional views and checks; for the evaluation of the data check the impact of other criteria should be taken into account (especially in case of high share of unknown)

1. Sourcing and processing of data

1.8 Data check and verification

Incomplete/censored data

- Different structures by combination of different portfolios: approximative solutions?
- Missing or too short history: use of market data (comparability?), interpolation
- Different level of correct coding: not only for the criterion as a whole but also for single keys (for example home ownership and existence of home insurance); question: unknown = no ownership?

1. Sourcing and processing of data

1.8 Data check and verification

Incomplete/censored data: example

- At start homer ownership not in the motor tariff
- Then enrichment by using the home insurance portfolio of the company as yes/no/unknown: yes = home insurance with the company which means other customer could be home owner as well (insured somewhere else)
- Later motor tariff criterion home ownership which means also home insurance somewhere else but slowly growing portfolio with correct coding!
- Ability and understanding for correct coding can lead to problems, for example no differentiation between no and unknown at the beginning

2. Model design

2.1 General remarks

2.2 Reasons for tariff differentiation

2.3 Selection of the relevant tariff criteria

2.4 Definition of classes for tariff criteria

2.5 Dependencies

2.6 GLM

2.7 Credibility and Statistical Learning

2.8 Factors impacting future development of portfolio and claims

2.9 Forecast future development of volume and profit based on assumptions

2.10 Principles on model selection and use of methods

2.11 Internal and external framework

2. Modelling design

2.1 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

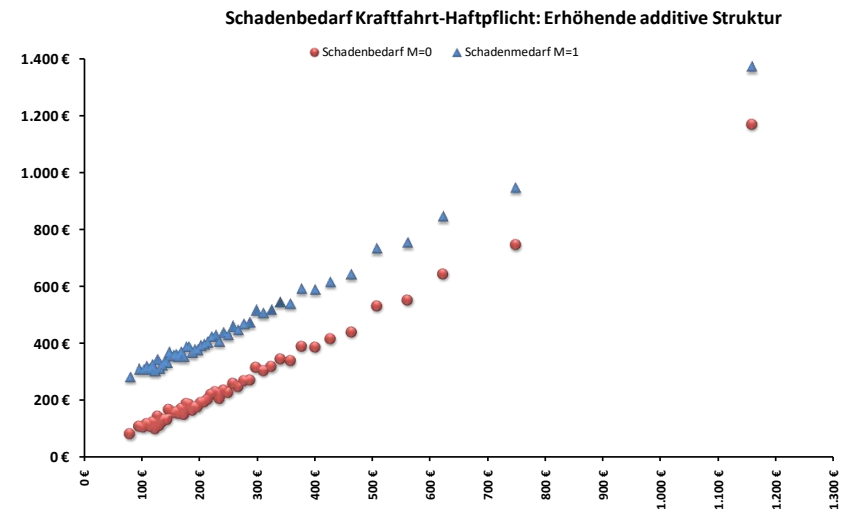
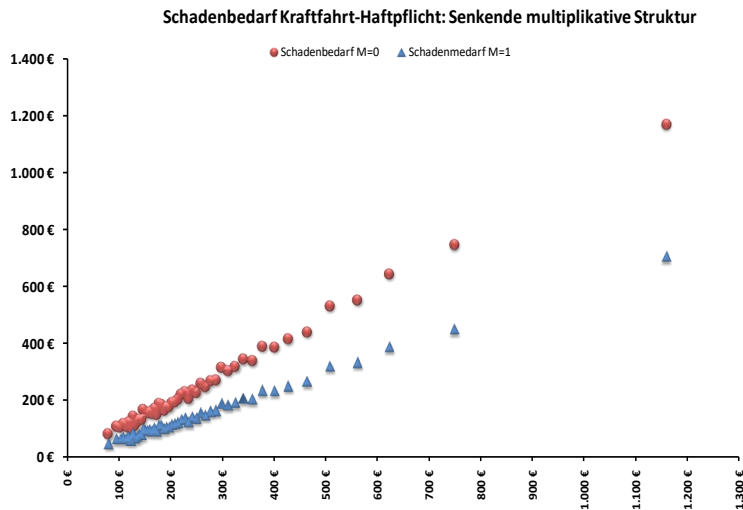
Random variations

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

2. Model design

2.1 General remarks

Check additive vs multiplicative for a dichotomic criterion



2. Model design

2.1 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

2. Model design

2.2 Reasons for tariff differentiation

- Avoid negative selection
- Improvement of loss ratio by avoiding 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!!!

2. Model design

2.2 Avoid negative selection

Year 1	Risk group	burning cost	premium Insur. 1	portfolio Insur. 1	premium Insur. 2	portfolio Insur. 2
	high	600	500	50%	500	50%
	low	400	500	50%	500	50%
	result/ total	500	0	100%	0	100%

Year 2	Risk group	burning cost	premium Insur. 1	portfolio Insur. 1	premium Insur. 2	portfolio Insur. 2
	high	600	500	60%	600	40%
	low	400	500	40%	400	60%
	result/ total	500	-20	100%	0	100%

2. Model design

Detailed explanations on substitution of potential tariff criteria

Assume that 100% of all risks with commercial use are in upper type classes and 100% of all risks in private use in lower type classes, then you evaluate both potential criteria as equal in terms of meaning and impact.

In such a case you have full substitution.

If we assume for type class and usage the risk distribution as just described and furthermore the risk premium for upper type classes and commercial use by 40% higher in each case, then the simple univariate „addition“ of both criteria would lead to a risk premium which would be 40% too high (double counting). In the same way you can also get too high discounts.

If the substitution is not full, but only partial, then the use of both criteria could be reasonable, but not by simple univariate „addition“, by application of a multivariate analysis for example with GLM including eventually modelling as interaction.

Real example: type class and mileage as the latter one was not used for the type classification by GDV, but mileage was already in use for pricing by the companies. This led to double counting for Diesel cars (too high surcharges as the usually higher mileage of Diesel cars was built in by type class and mileage as well).

2. 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 ist not allowed for new business

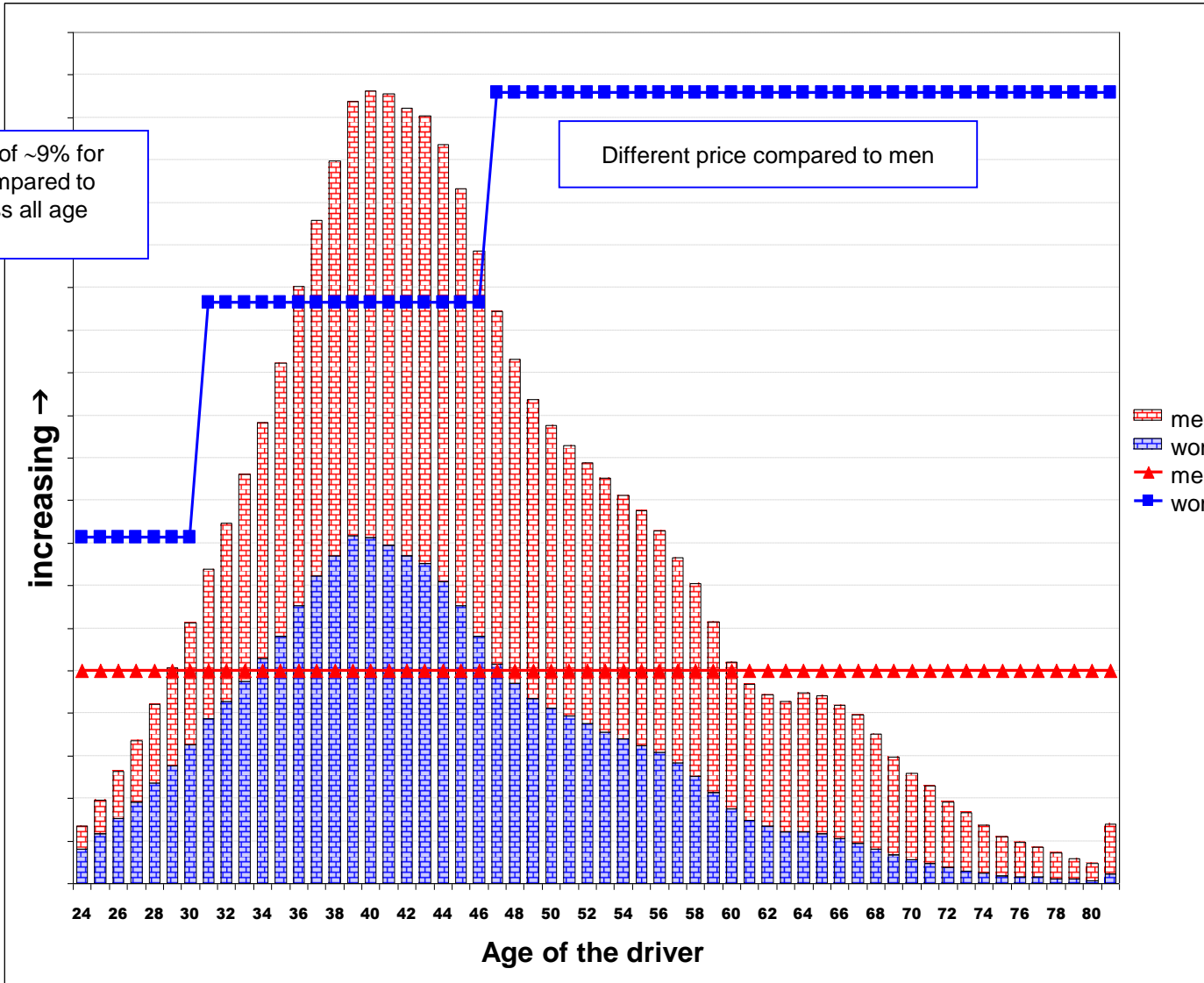
In Germany the customer has to cancel actively, otherwise the existing contract stays valid => this does not apply for renewing business

In the UK it's different: all policies are running out at due date

2. Model design: interaction age/sex (age 24 – 81)

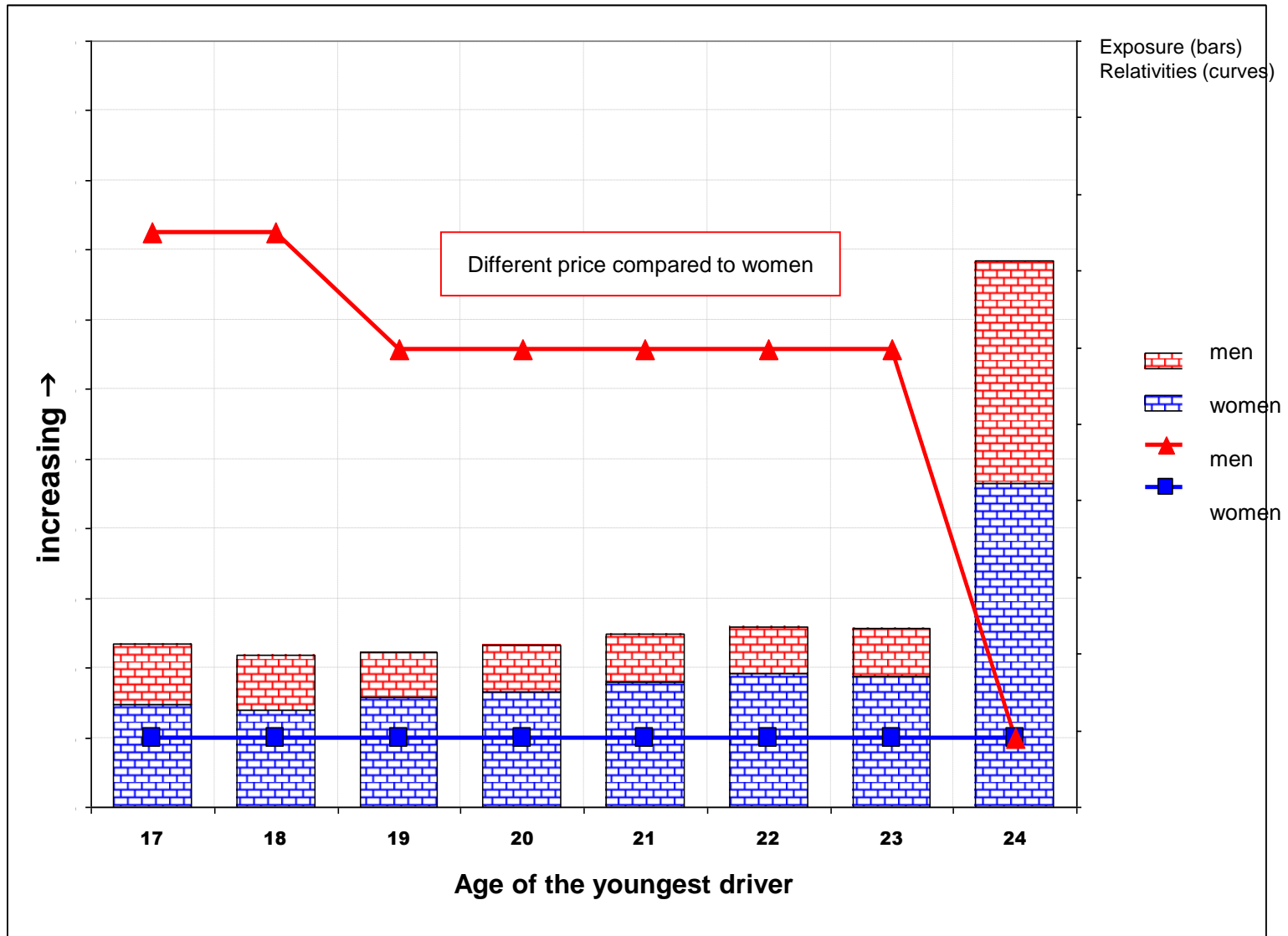
Surcharge of ~9% for women compared to men (across all age groups)

Different price compared to men

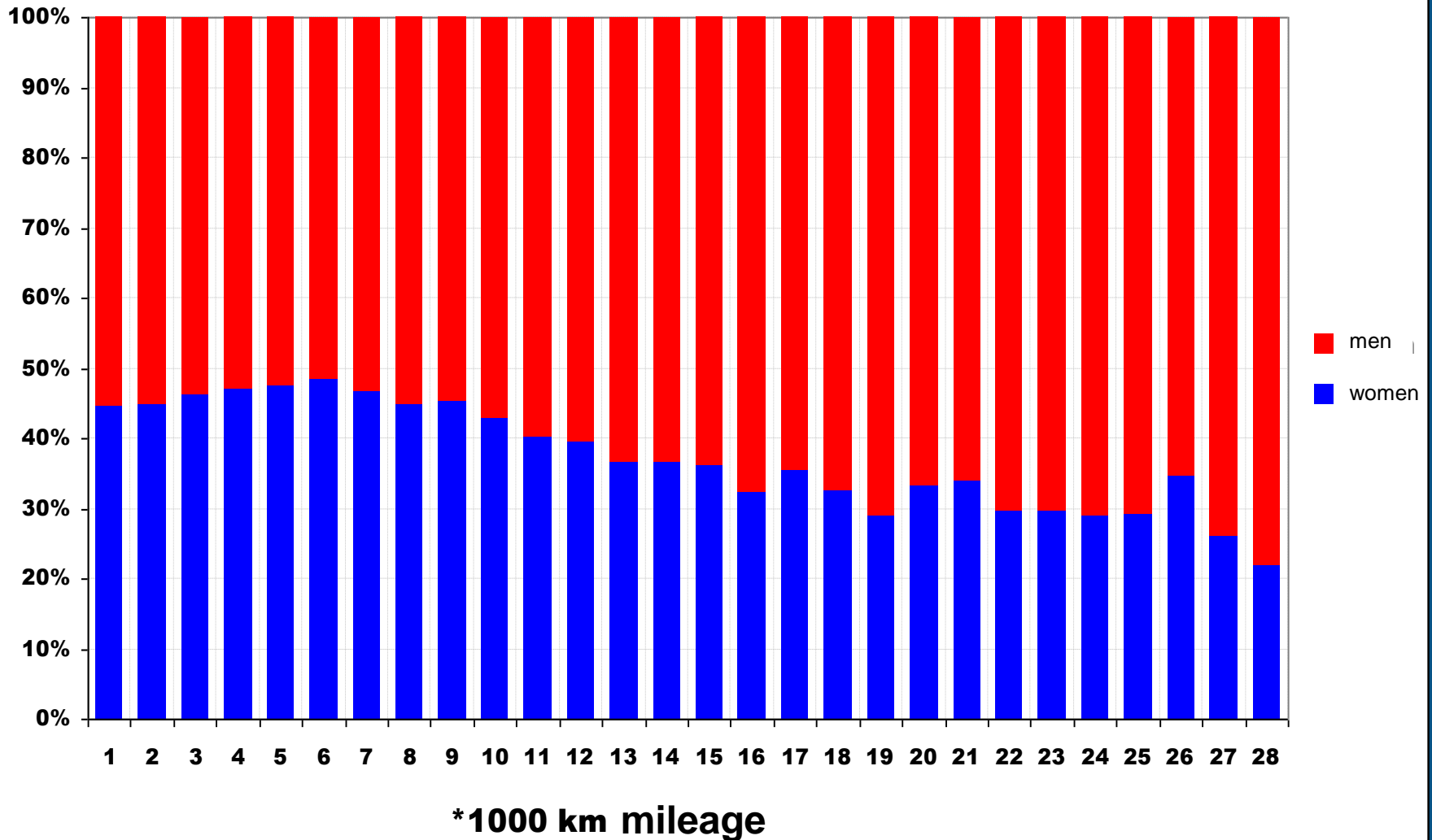


Exposure (bars)
 Relativities (curves)

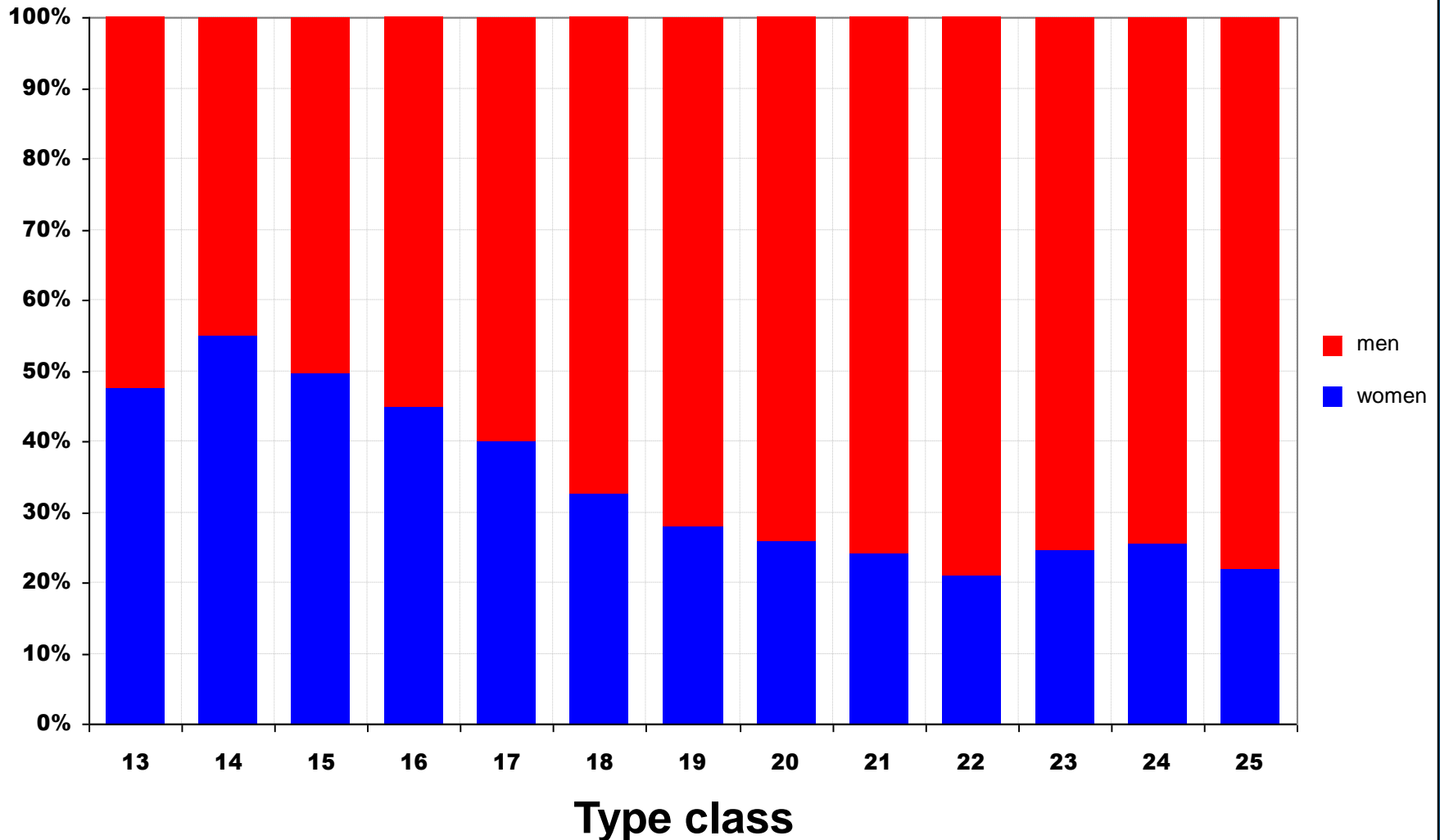
2. Model design: interaction age/sex (age 17 – 24)



2. Model design: portfolio distribution mileage by sex (partial substitution)



2. Model design: portfolio distribution type class by sex (partial substitution)



2. 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.**

2. Model design

2.3 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)

**Target:
systematic
differentiation
only**

2. Model design

2.4 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

2. Model design

2.5 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

2. Model design

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

Exposure	young	old	total
men	400	200	600
women	200	400	600
total	600	600	1200

Frequency	young	old	total
men	40,0%	20,0%	33,3%
women	20,0%	10,0%	13,3%
total	33,3%	13,3%	23,3%

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

2. Model design

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

Exposure	young	old	total
men	600	300	900
women	400	200	600
total	1000	500	1500

Frequency	young	old	total
men	60,0%	20,0%	46,7%
women	20,0%	10,0%	16,7%
total	44,0%	16,0%	34,7%

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.

2. Model design

2.5 Dependencies

- Modelling: for example 1 dimension out of 2 criteria
- Example on correlation: arguments from -2 to 2 and square function give corr. zero!!!

$$\rho_{XY} = \frac{\sum (X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum (X_i - \bar{X})^2 \sum (Y_i - \bar{Y})^2}}$$

2. Model design

2.6 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

2. Model design

2.6 GLM: Why not simply multiplication of marginal values?

Exp/BC	1	2	total
1	900/20,0	30/23,0	930/20,1
2	900/22,7	170/26,7	1070/23,3
total	1800/21,3	200/26,1	2000/21,8

Index	1	2	total
1	91,7	105,5	92,2
2	104,1	122,5	106,9
total	97,7	119,7	100,0

Multiplying of the indexed values leads to:

Index	1	2	total
1	90,1	110,4	92,2
2	104,4	128,0	106,9
total	97,7	119,7	100,0

This is obviously clearly deviating due to portfolio mix effects.

2. Model design

2.6 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):

$$BC_{11} = 19,99 (91,6; 90,1; 91,7)$$

$$BC_{12} = 23,43 (107,3; 110,4; 105,5)$$

$$BC_{21} = 22,71 (104,1; 104,4; 104,1)$$

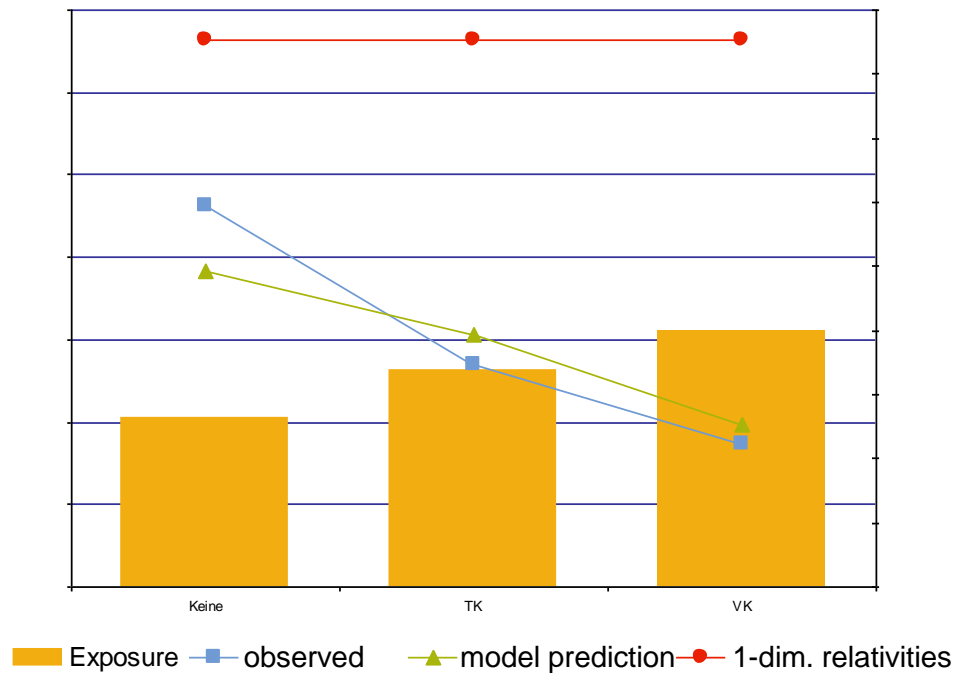
$$BC_{22} = 26,62 (122,0; 128,0; 122,5)$$

This demonstrates a clearly better fit than multiplying marginal values.

2. Model design

2.6 GLM: Examples

MTPL PD frequency: take up of MOD

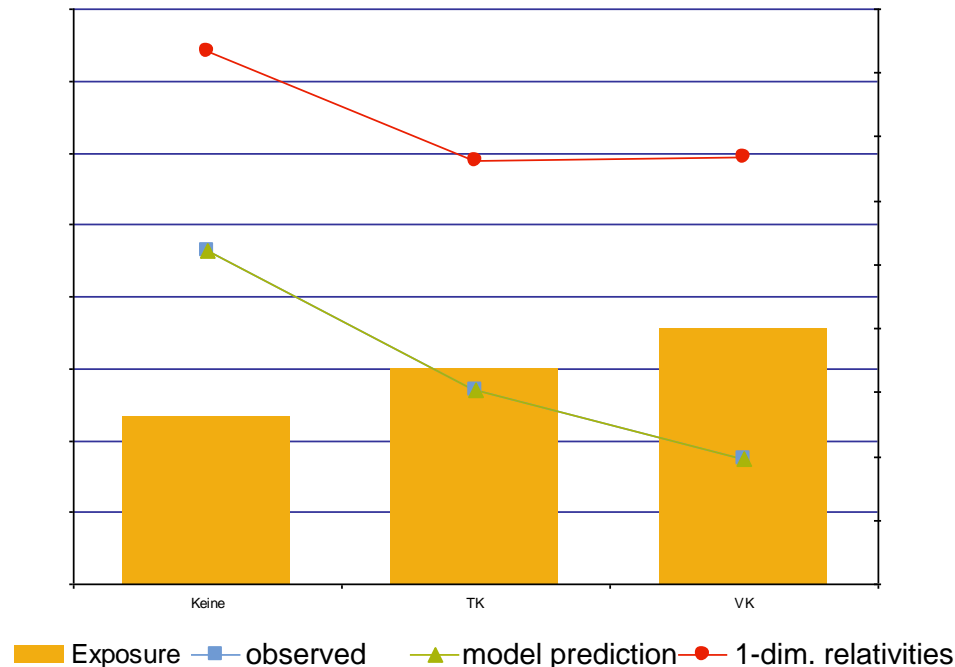


Model w/o Kasko take up: Inclusion in model could make sense

2. Model design

2.6 GLM: Examples

MTPL PD frequency: take up of MOD

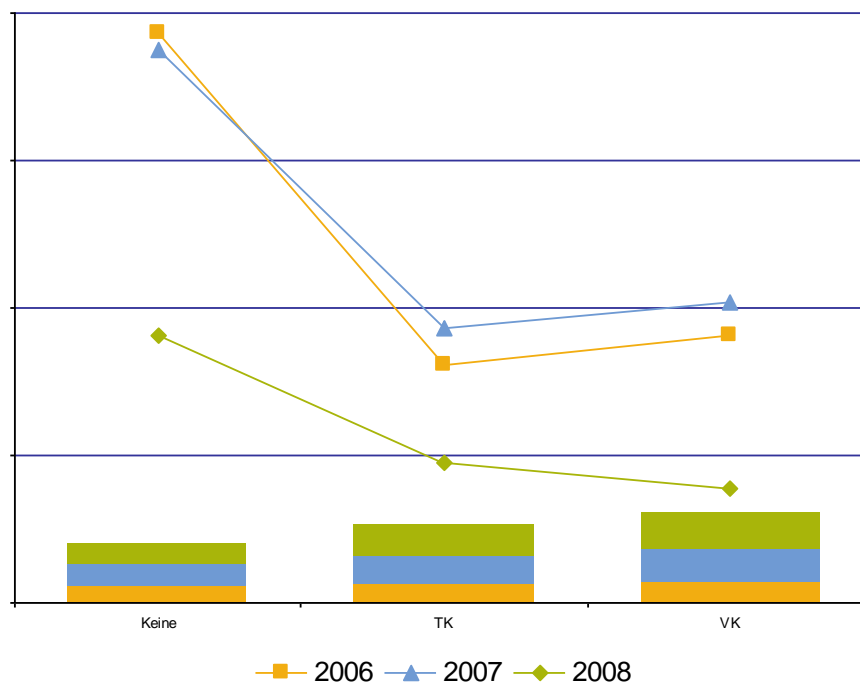


Model with Kasko take up: differentiation by full comprehensive/fire&theft seems reasonable

2. Model design

2.6 GLM: Examples

MTPL PD frequency: take up of MOD

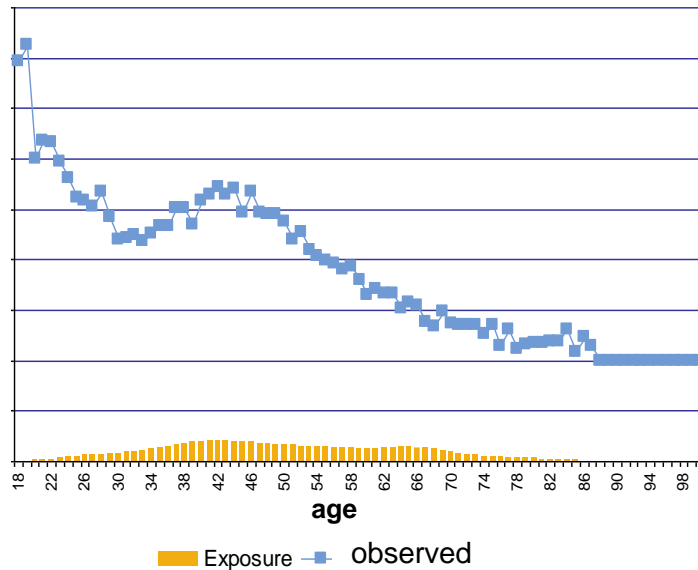


Model with Kasko take up: check of consistency over time
 ⇒ Full comprehensive and fire&theft take up only combined reasonable
 this could not be detected by a test on the basis of aggregated data over time!

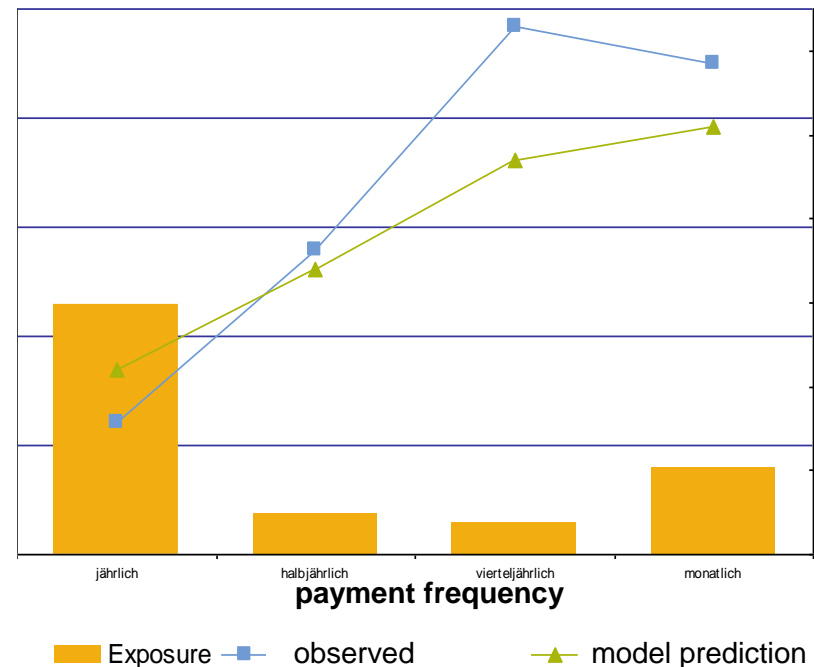
2. Model design

2.6 GLM: Examples

Theft of bikes: frequency



Theft of bikes: frequency

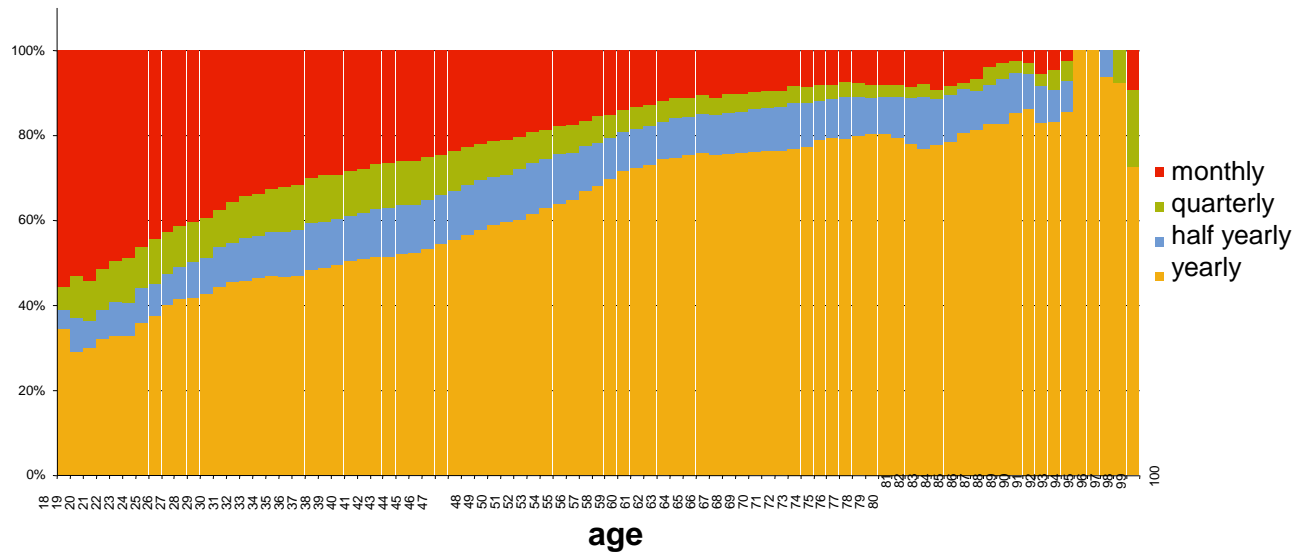


Model with age =>
Quite good regarding payment frequency: dependencies?

2. Model design

2.6 GLM: Examples

Distribution of payment frequency by age

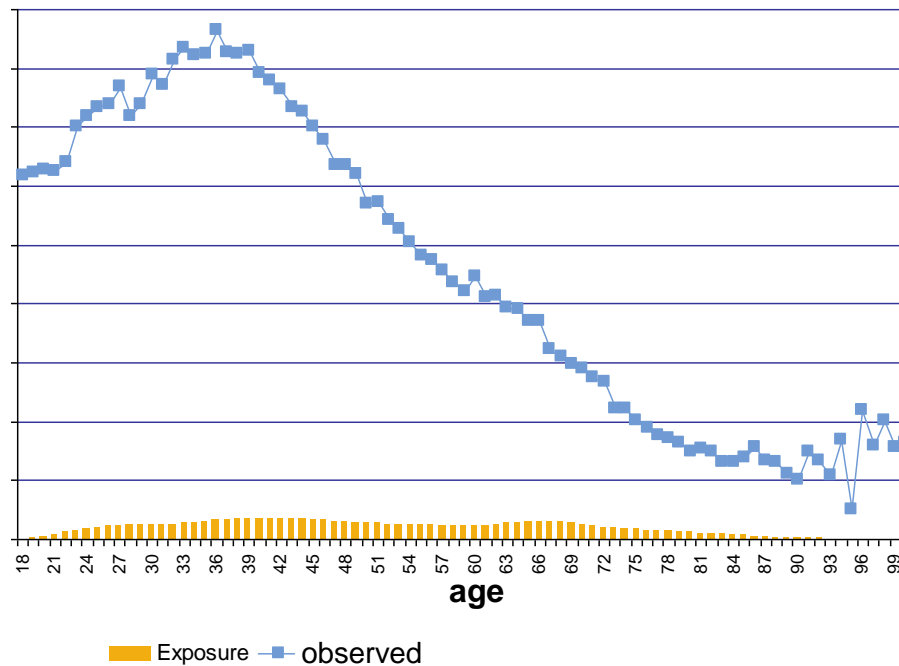


Payment frequency: dependency with age

2. Model design

2.6 GLM: Examples

Private liability: frequency

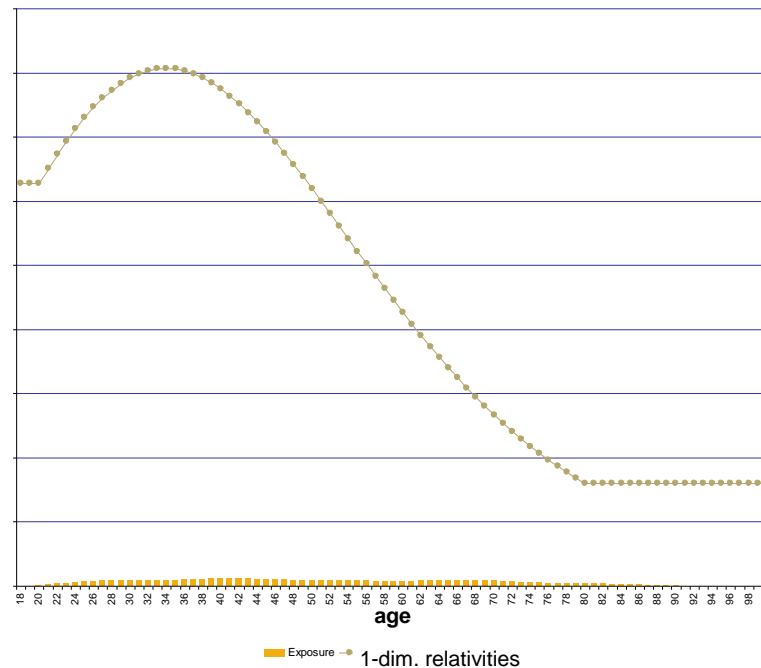


Private liability: age as a function?

2. Model design

2.6 GLM: Examples

Private liability: frequency

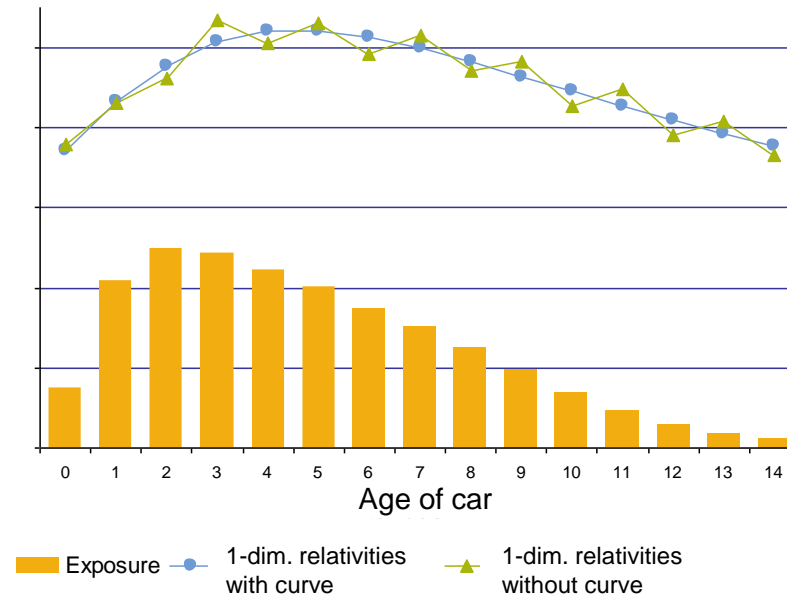


Private liability: age modelled as polynomial

2. Model design

2.6 GLM: Examples

MOD glass frequency

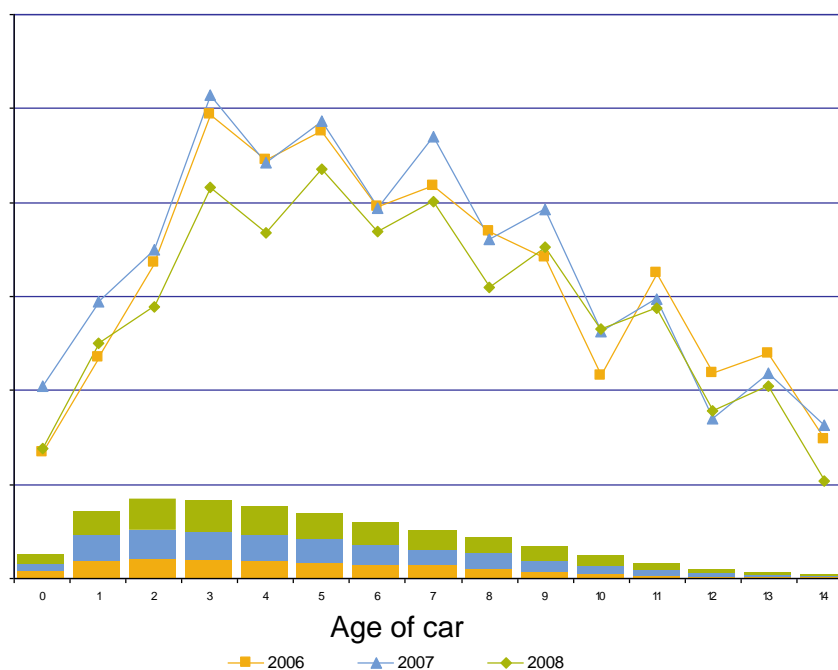


Age of car modelled as function?

2. Model design

2.6 GLM: Examples

MOD glass frequency: age of car by year

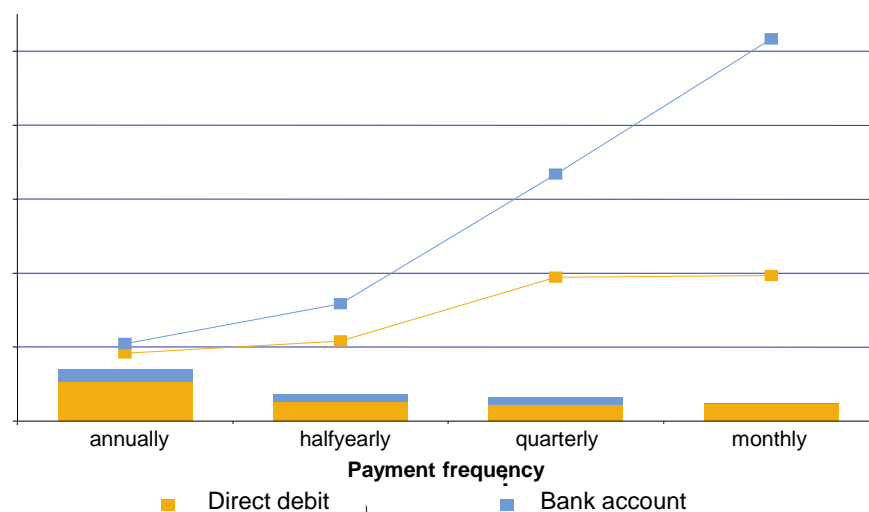


Age of car as function: Impact of technical check up every two years starting after three years => not adequate

2. Model design

2.6 GLM: Examples

Payment frequency x payment mode



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

2. Model design

2.7 Credibility

Purpose/Situations of application/pre-conditions:

- Potential examples of application are motor fleets (single fleets can be too small for an own analysis, but as part of total fleet business it's possible to align a certain credibility of the claims experience of each fleet as surcharge/discount on the base level) or classifications of regions of car types (single regions or car types only show a small data base which only allows for partial credibility as modification of a base price of a larger portfolio of similar/equal risks)
- This is consequently not working for evaluating the theft risk for normal and holiday flats, as holiday flats represent a priori a higher risk (more periods without people living in these flats: a priori not similar/equal risks). Credibility is only applicable in case of risks which are not a priori distinct.

2. Model design

2.7 Credibility

Purpose/Situations of application/pre-conditions:

- But in some cases even a given tariff (for example fleets can be composed out of different risks like cars, trucks etc or be different by engine power which is represented in the tariff) is not a principal obstacle for an application of credibility: credibility can be applied on loss ratios of a given tariff or burning costs can be normalised with a tariff and credibility plus GLM used recursively
- In general credibility is weighted average between a certain base level and an individual level (see fleet portfolio and single fleet)

2. Model design

2.7 Statistical Learning

- Decision trees (for example canx yes/no) incl Bagging, Boosting, Random Forest (Aggregation of trees, random selection of records and dimensions): Such algorithm can be used to get orientation in big amounts of data (records and dimensions) as behavioural data on the internet, telematics to filter relevant information, more automatic detection of dependencies (not possible with GLM)
- Neuronal Nets (similar to regression?)
- Bootstrap (for example reserve analysis to generate distributions of potential outcomes)
- Unsupervised learning: algorithms without target value like clusteranalysis but only a new name (opposite: supervised learning like GLM)

2. Model design

2.8 Factors impacting future development of portfolio and claims

- Claims trends: for example more Nat Cat (climate change: increased frequency and severity plus areas hit but formerly not); glass claims (potential change of customer behaviour: no deductible applied in case repair instead of exchange, see advertising), medical and health care expenses for BI claims (super imposed inflation)
- Inflation: global level of tariff; clear impact on threshold for large claims (index clause for XL RI) within few years
- Canx: caused by market development, pricing, customer behaviour (some of customer behaviour and canx can be modelled, elasticity for example, and taken into account for pricing)
- NB/BoB mix: strongly growing portfolio; deferred impact of decreasing NB prices => UW cycle; different prices by tariff generation (if possible)

2. Model design

2.8 Factors impacting future development of portfolio and claims

Example NB/BoB mix

- Start with AVP 400 in BoB and 200 in NB => total AVP = 400
- after 1 year 25% of portfolio (in total constant number of policies) in NB tariff (for example car replacement by existing customer or new customer) => total AVP = 350
- additionally 25% NB => total AVP = 320

Outcome: Even in case of big differences between NB and BoB rates the lower NB rate level is impacting the total AVP with some delay!

2. Model design

2.8 Factors impacting future development of portfolio and claims

- Adjustment of rates with respect to volume, competition and profit (global level as well as in segments, which implies eventually deviation between risk model and tariff); potential impact of steering of claims management; RI (see higher BI frequency for young driver)
- essential parameters: AVP, frequency, average claim cost, number of policies, acceptance by customers (demand/elasticity), reaction of competitors (especially global level), potential selection effects (vs. competitors when introducing an USP product; deliberate choice of deductible by customers)

2. Model design

2.9 Forecast future development of volume and profit based on assumptions

- Certain segments, products, tariffs: assumptions on market/competition, claims, sales volume, shift in portfolio mix, expense development
- in some circumstances there are centrally provided forecasts: always to check their applicability
- main purpose: definition of global rating level
- LTV (lifetime value)

2. Model design

2.9 Forecast future development of volume and profit based on assumptions

Trends existing => pure average not ok

Crucial for estimation of trends:

Identification of all components (also in terms of interaction) and adequate consideration

Ideally the actuary will do these steps:

- Measure of global trend separate for frequency and average claim costs (potentially different driver of trends)
- Measure of portfolio shift regarding relevant risk criteria and estimation of impact on frequency and average claim costs

2. Model design

2.9 Forecast future development of volume and profit based on assumptions

- Measure of impact of criteria not relevant for pricing as for example time being in the portfolio (change of tariff generation, different coverages), UW guidelines incl their adjustment
- Evaluation of pure trend out of global trend reduced by the impact of portfolio shift (for tariff generations by product strategy)
- Definition of global level as trend (if volatile) or last years ' value (if stable) incl. extrapolation to mid of running period of the tariff
- Additional consideration of general changes like legal ones

2. Model design

2.9 Forecast future development of volume and profit based on assumptions

- Definition of global level of the tariff for the next period taking into account trends, developments etc
- Quantification by using the (NB) policies of the recent period for re-rating with the new tariff is based on the assumption of getting the same risk mix.
- BUT: Normally the new tariff enables a new risk evaluation which drives slightly different risk factors or introduces a new rating dimension which leads to larger changes. This will end up in getting a different risk mix compared to the current tariff which is normally hard to predict.
- Therefore the performance of a new tariff has to be monitored closely in the first weeks after introduction to derive eventually a necessary adjustment regarding the targeted global level

2. Model design

2.9 Forecast future development of volume and profit based on assumptions

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 canx 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

2. Model design

2.9 Forecast future development of volume and profit based on assumptions Lifetime value: example

	Years										
	1	2	3	4	5	6	7	8	9	10	Summe
AVP	500	509,90	520,00	530,30	540,80	551,50	562,43	573,56	584,92	596,50	
#Policies	10.000	9.000	8.100	7.290	6.561	5.905	5.314	4.783	4.305	3.874	
Loss ratio	80%	79,22%	78,45%	77,69%	76,94%	76,19%	75,45%	74,72%	73,99%	73,28%	
Canx rate	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	
Price adjustment	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	
Claims inflation	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	
Discount rate	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	
Acquisition costs	100										100
Admin costs	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	
Result per policy	-30,00	75,35	80,84	86,48	92,27	98,22	104,32	110,59	117,02	123,62	858,71
Result total	- 300.000,00	678.118,81	654.789,04	630.425,47	605.381,86	579.958,41	554.408,41	528.944,09	503.741,85	478.946,90	4.914.714,85

	Years										
	1	2	3	4	5	6	7	8	9	10	Summe
AVP	500	509,90	520,00	530,30	540,80	551,50	562,43	573,56	584,92	596,50	
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Canx rate	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	
Price adjustment	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	
Claims inflation	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	
Discount rate	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	
Acquisition costs	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	
	40,00	40,79	41,60	42,42	43,26	44,12	44,99	45,89	46,79	47,72	437,59
Admin costs	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	
Result per policy	30,00	34,55	39,24	44,05	49,01	54,10	59,33	64,70	70,23	75,90	521,11
Result total	300.000,00	310.990,10	317.830,31	321.157,41	321.528,90	319.431,98	315.291,58	309.477,45	302.310,59	294.068,90	3.112.087,21

2. Model design

2.10 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

2. Model design

2.10 Principles on model selection and use of methods

Vaccine example

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

	B	B'
AC	1/43	14/43
AC'	4/43	10/43
A'C	1/43	10/43
A'C'	1/43	2/43

$P(A/B, C) = 1/2 < P(A/B', C) = 7/12$ 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:
$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

2. Model design

2.11 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)

2. Model design

2.11 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

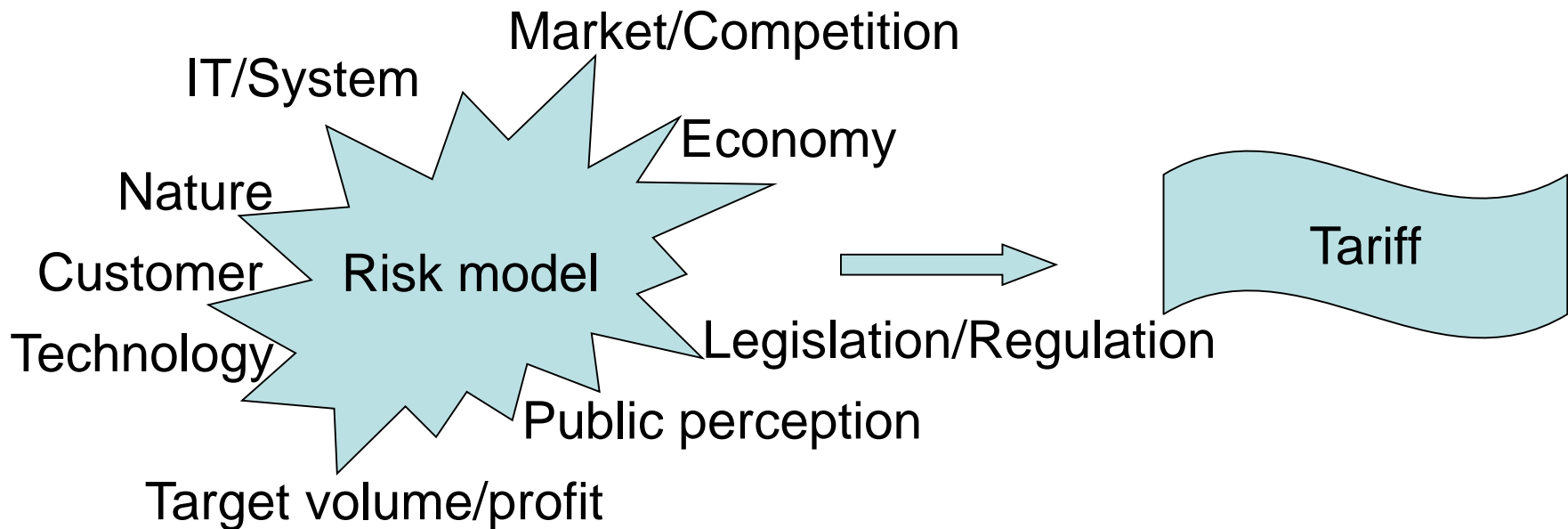
2. Model design

2.11 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)

2. Model design

2.11 Internal and external framework



3. 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

1. Pushed by J. Lemaire´s talk ASTIN 2013/Deregulation in EU as starting point

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, then 39, currently 49)
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....

**More possible
tariff cells than
cars in Germany!**

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

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 (recently to 49)
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

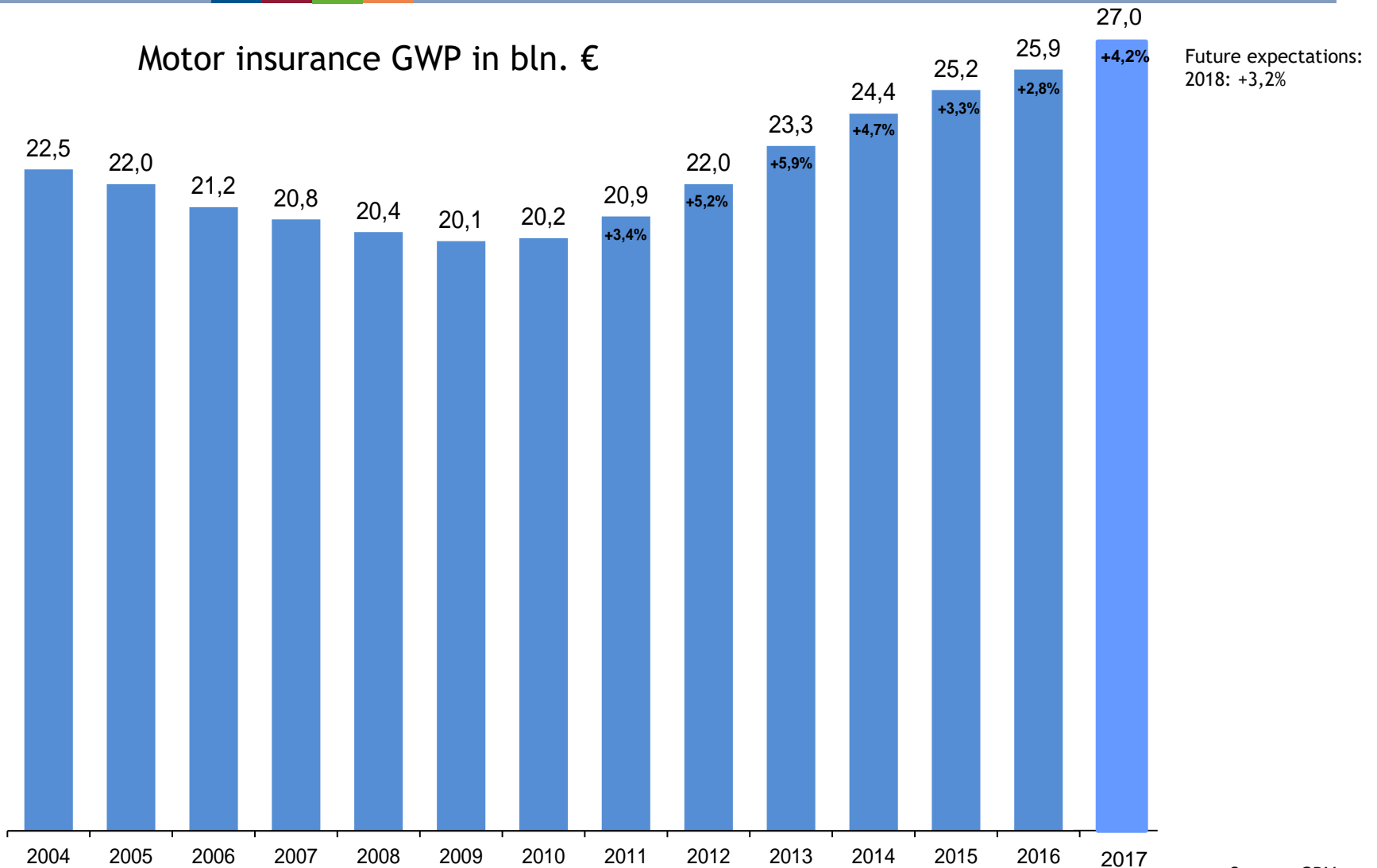
Some background information on the German motor insurance market to highlight/detail what was/is going on with certain tariff dimensions:

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 27 bln€ premium by something like 25%. 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.

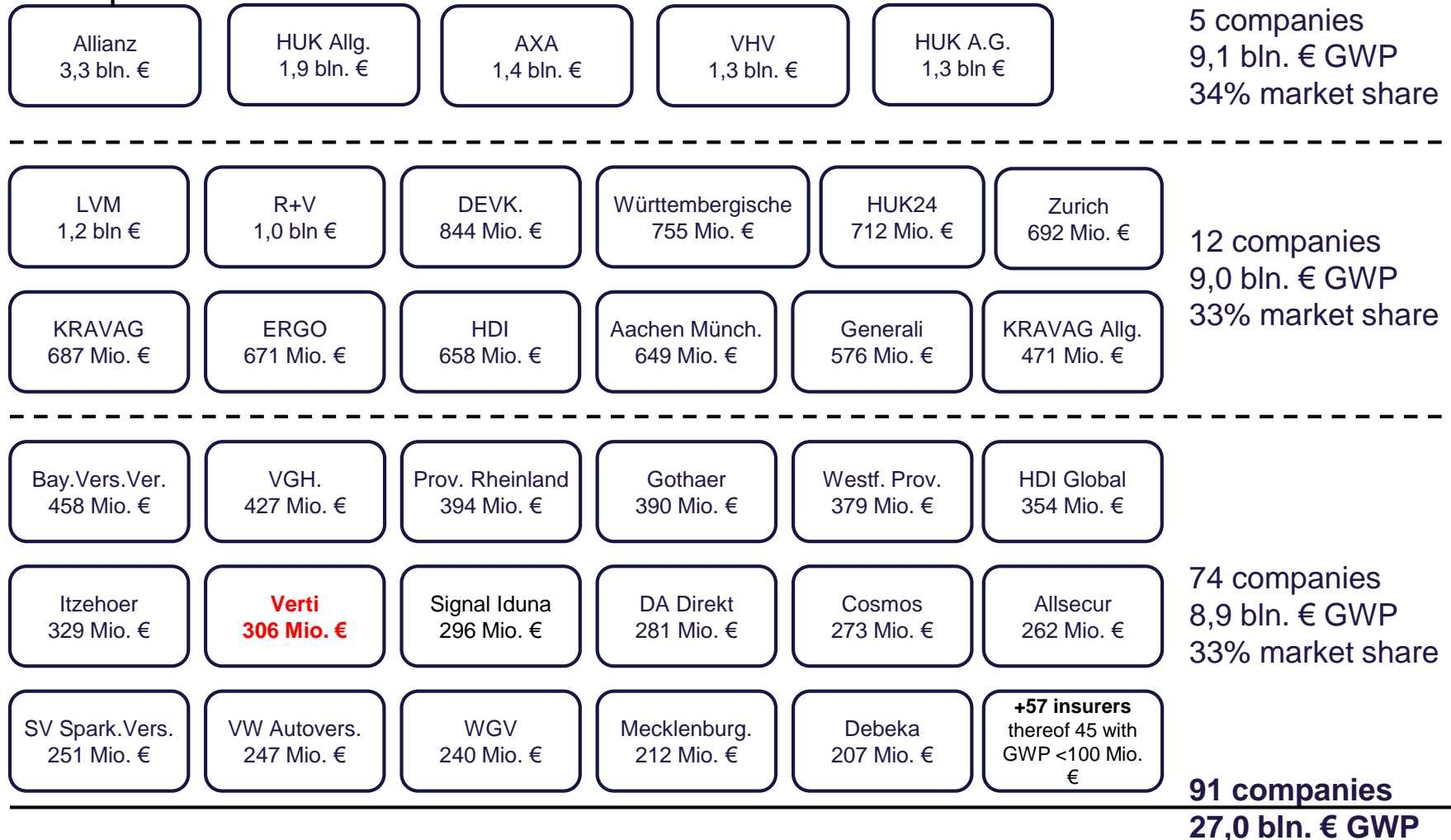
4. Stability and checks in comparison to other criteria incl market overview

Motor insurance GWP in bln. €



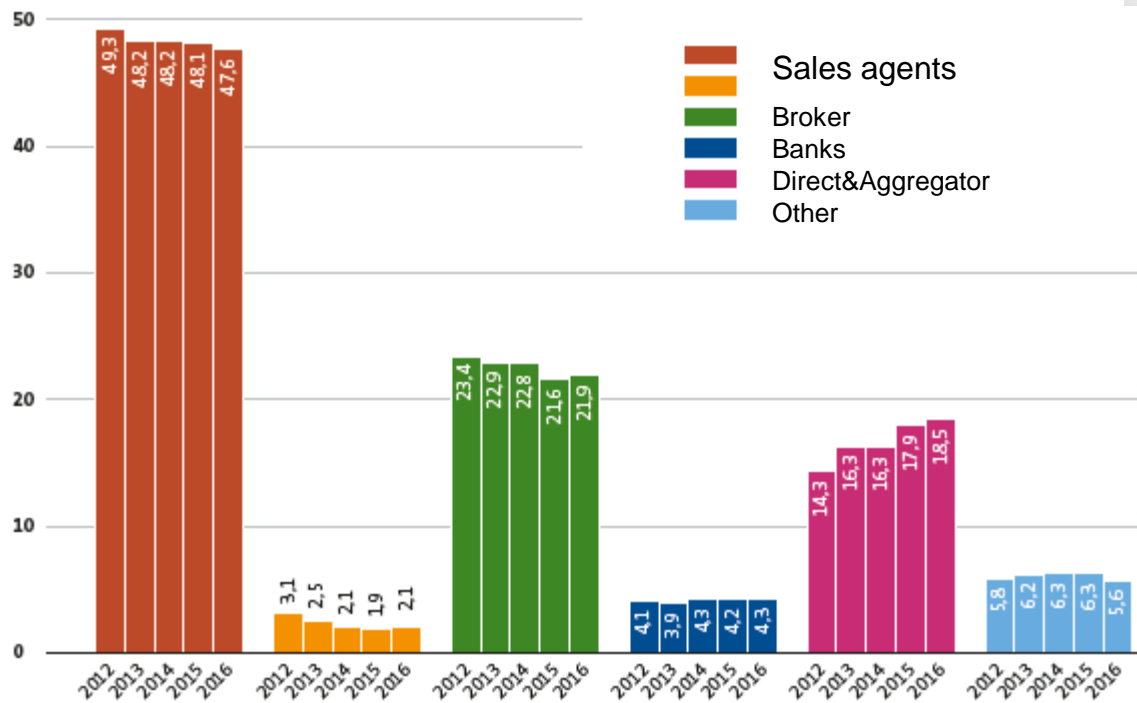
4. Stability and checks in comparison to other criteria incl market overview

Competitive environment 2017: 91 motor insurers



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

Sales channel split for motor insurance new business



Source: „Anteile der Vertriebswege am Beitragsaufkommen“; published by GDV yearly

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. 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 (49), 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 173m 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

6. Brief description of BMS

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)

Portfolio distribution Relativities/factors

old

Ausprägungen des SF-Merkmals	Jahreseinheiten			SF-Indizes Schadenbedarfe indiziert auf SF 1	untere SF-Indexgrenze	obere SF-Indexgrenze
	absolut	%-Ant.	kumul.			
1	2	3	4	5	6	7
M	6.133,2	0,04	0,04	246	219	274
0	30.288,0	0,19	0,23	230	214	247
S	42.491,4	0,27	0,50	157	147	169
SF 1/2	684.211,9	4,37	4,87	138	134	142
SF 1	731.547,3	4,67	9,54	100	97	103
SF 2	738.358,9	4,71	14,26	83	80	86
SF 3	747.989,6	4,78	19,04	71	68	73
SF 4	743.054,3	4,74	23,78	62	60	64
SF 5	703.109,9	4,49	28,27	57	55	59
SF 6	706.709,7	4,51	32,78	54	52	56
SF 7	718.317,4	4,59	37,37	51	49	53
SF 8	710.817,1	4,54	41,91	48	47	50
SF 9	678.374,4	4,33	46,24	46	44	47
SF 10	761.591,4	4,86	51,10	43	42	45
SF 11	764.530,5	4,88	55,99	43	41	44
SF 12	613.168,0	3,92	59,90	40	38	42
SF 13	542.042,5	3,46	63,36	39	37	41
SF 14	517.614,3	3,31	66,67	39	37	41
SF 15	554.533,7	3,54	70,21	38	36	39
SF 16	539.183,8	3,44	73,65	37	36	39
SF 17	435.829,3	2,78	76,43	36	34	38
SF 18	454.718,0	2,90	79,34	36	35	38
SF 19	389.710,9	2,49	81,83	34	33	36
SF 20	377.456,8	2,41	84,24	34	33	36
SF 21	368.357,3	2,35	86,59	33	32	35
SF 22	241.178,4	1,54	88,13	32	30	34
SF 23	210.891,3	1,35	89,48	32	30	34
SF 24	205.128,7	1,31	90,79	32	30	34
SF 25	1.443.015,2	9,21	100,00	29	28	30
Gesamt	15.660.353,2	100				

NCD classes

S/SF-Stufe	Statistikjahre 2008 - 2010				
	Jahreseinheiten		Schadenbedarfs-Indizes		Konfidenzintervall ¹ (Intervallgrenzen: Schadenbedarfs-Index * (1 ± ... %))
	Absolut	Anteil in %	auf gewichteten Mittelwert 1 indiziert	indiziert auf SF 1 = 100	
1	2	3	4	5	6
M	21.631	0,0	3,9554	221,8	6,66
0	116.401	0,1	2,7981	156,9	3,19
S	173.509	0,2	2,5168	141,1	2,98
SF 1/2	1.684.172	1,7	2,2177	124,3	1,04
SF 1	1.741.270	1,7	1,7837	100,0	1,13
SF 2	2.687.160	2,7	1,6462	92,3	0,98
SF 3	2.957.755	3,0	1,5318	85,9	0,99
SF 4	3.394.783	3,4	1,4351	80,5	0,96
SF 5	3.616.968	3,6	1,3523	75,8	0,96
SF 6	3.745.247	3,8	1,2806	71,8	0,96
SF 7	3.751.748	3,8	1,2179	68,3	1,00
SF 8	3.606.459	3,6	1,1627	65,2	1,04
SF 9	3.658.843	3,7	1,1136	62,4	1,07
SF 10	3.838.923	3,9	1,0697	60,0	1,05
SF 11	3.954.142	4,0	1,0302	57,8	1,03
SF 12	3.583.514	3,6	0,9945	55,8	1,13
SF 13	3.382.024	3,4	0,9620	53,9	1,18
SF 14	3.185.544	3,2	0,9324	52,3	1,26
SF 15	3.026.702	3,0	0,9053	50,8	1,31
SF 16	2.874.794	2,9	0,8803	49,4	1,35
SF 17	2.716.363	2,7	0,8573	48,1	1,39
SF 18	2.666.924	2,7	0,8360	46,9	1,43
SF 19	2.623.452	2,6	0,8162	45,8	1,42
SF 20	2.609.067	2,6	0,7978	44,7	1,42
SF 21	2.515.485	2,5	0,7806	43,8	1,50
SF 22	3.015.915	3,0	0,7645	42,9	1,37
SF 23	2.960.610	3,0	0,7494	42,0	1,37
SF 24	2.782.919	2,8	0,7353	41,2	1,44
SF 25	2.557.335	2,6	0,7219	40,5	1,51
SF 26	2.380.773	2,4	0,7094	39,8	1,59
SF 27	2.300.295	2,3	0,6975	39,1	1,64
SF 28	2.149.080	2,2	0,6863	38,5	1,66
SF 29	1.926.993	1,9	0,6757	37,9	1,79
SF 30	1.663.672	1,7	0,6656	37,3	1,96
SF 31	1.339.134	1,3	0,6560	36,8	2,19
SF 32	1.290.774	1,3	0,6469	36,3	2,26
SF 33	1.057.201	1,1	0,6383	35,8	2,48
SF 34	896.098	0,9	0,6300	35,3	2,77
SF 35	5.089.021	5,1	0,5842	32,8	1,21
Gesamt	99.542.693	100,0			

new

Confidence intervals

Factors relative to reference class (deliberate choice)

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

6. Brief description of BMS: comparison old/new TPL downgrade

old

SF- Merkmal im Schadenjahr	RÜCKSTUFUNG bei ... nach ...	
	1 Schaden	2 Schäden
	1	2
SF 25	SF 11	SF 4
SF 24	SF 11	SF 4
SF 23	SF 10	SF 4
SF 22	SF 10	SF 4
SF 21	SF 10	SF 4
SF 20	SF 9	SF 3
SF 19	SF 9	SF 3
SF 18	SF 7	SF 3
SF 17	SF 7	SF 2
SF 16	SF 6	SF 2
SF 15	SF 6	SF 2
SF 14	SF 6	SF 2
SF 13	SF 5	SF 2
SF 12	SF 5	SF 1
SF 11	SF 5	SF 1
SF 10	SF 4	SF 1
SF 9	SF 4	SF 1
SF 8	SF 4	SF 1
SF 7	SF 3	SF 1/2
SF 6	SF 3	SF 1/2
SF 5	SF 2	SF 1/2
SF 4	SF 2	SF 1/2
SF 3	SF 1	S
SF 2	SF 1/2	S
SF 1	S	M
SF 1/2	S	M
S	M	M
0	M	M
M	M	M

new

SF-Merkmal im Schadenjahr	RÜCKSTUFUNG bei ... nach ...	
	1 Schaden	2 Schäden
	1	2
SF 35	SF 20	SF 8
SF 34	SF 17	SF 7
SF 33	SF 16	SF 7
SF 32	SF 16	SF 6
SF 31	SF 15	SF 6
SF 30	SF 15	SF 6
SF 29	SF 14	SF 6
SF 28	SF 14	SF 5
SF 27	SF 13	SF 5
SF 26	SF 13	SF 5
SF 25	SF 12	SF 4
SF 24	SF 12	SF 4
SF 23	SF 11	SF 4
SF 22	SF 11	SF 4
SF 21	SF 10	SF 3
SF 20	SF 10	SF 3
SF 19	SF 9	SF 3
SF 18	SF 9	SF 2
SF 17	SF 8	SF 2
SF 16	SF 8	SF 2
SF 15	SF 7	SF 1
SF 14	SF 6	SF 1
SF 13	SF 6	SF 1
SF 12	SF 5	SF 1
SF 11	SF 5	SF 1
SF 10	SF 4	SF 1/2
SF 9	SF 3	SF 1/2
SF 8	SF 3	SF 1/2
SF 7	SF 2	SF 1/2
SF 6	SF 2	S
SF 5	SF 1	S
SF 4	SF 1	0
SF 3	SF 1	0
SF 2	SF 1/2	0
SF 1	SF 1/2	0
SF 1/2	0	M
S	0	M
0	M	M
M	M	M

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

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

NCD classes previous year

Ausprägung des SF-MerkmaIs im VJ	Schadenbedarfe der Risiken im StJ mit genau ... Schäden im VJ			Schadenbedarfe des SF-MerkmaIs im StJ Bedarf Ausprägung	
	0 Schäden	1 Schaden	2 Schäden	5	6
1	2	3	4	5	6
M				853	M
0	567	765	1.049	659	0
SF 1/2	526	708	971	610	SF 1/2
SF 1	467	617	846	532	SF 1
SF 2	418	565	774	457	SF 2
SF 3	387	522	716	418	SF 3
SF 4	350	473	648	387	SF 4
SF 5	328	442	606	350	SF 5
SF 6	309	417	572	328	SF 6
SF 7	296	399	547	309	SF 7
SF 8	275	371	508	296	SF 8
SF 9	261	353	484	275	SF 9
SF 10	248	335	459	261	SF 10
SF 11	242	327	448	248	SF 11
SF 12	228	308	422	242	SF 12
SF 13	219	296	406	228	SF 13
SF 14	212	287	393	219	SF 14
SF 15	206	278	381	212	SF 15
SF 16	201	271	372	206	SF 16
SF 17	199	268	368	201	SF 17
SF 18	193	260	356	199	SF 18
SF 19	186	251	344	193	SF 19
SF 20	177	239	328	186	SF 20
SF 21	169	228	313	177	SF 21
SF 22	163	220	301	169	SF 22
SF 23	158	213	292	163	SF 23
SF 24	155	210	287	158	SF 24
SF 25	140	189	259	142	SF 25

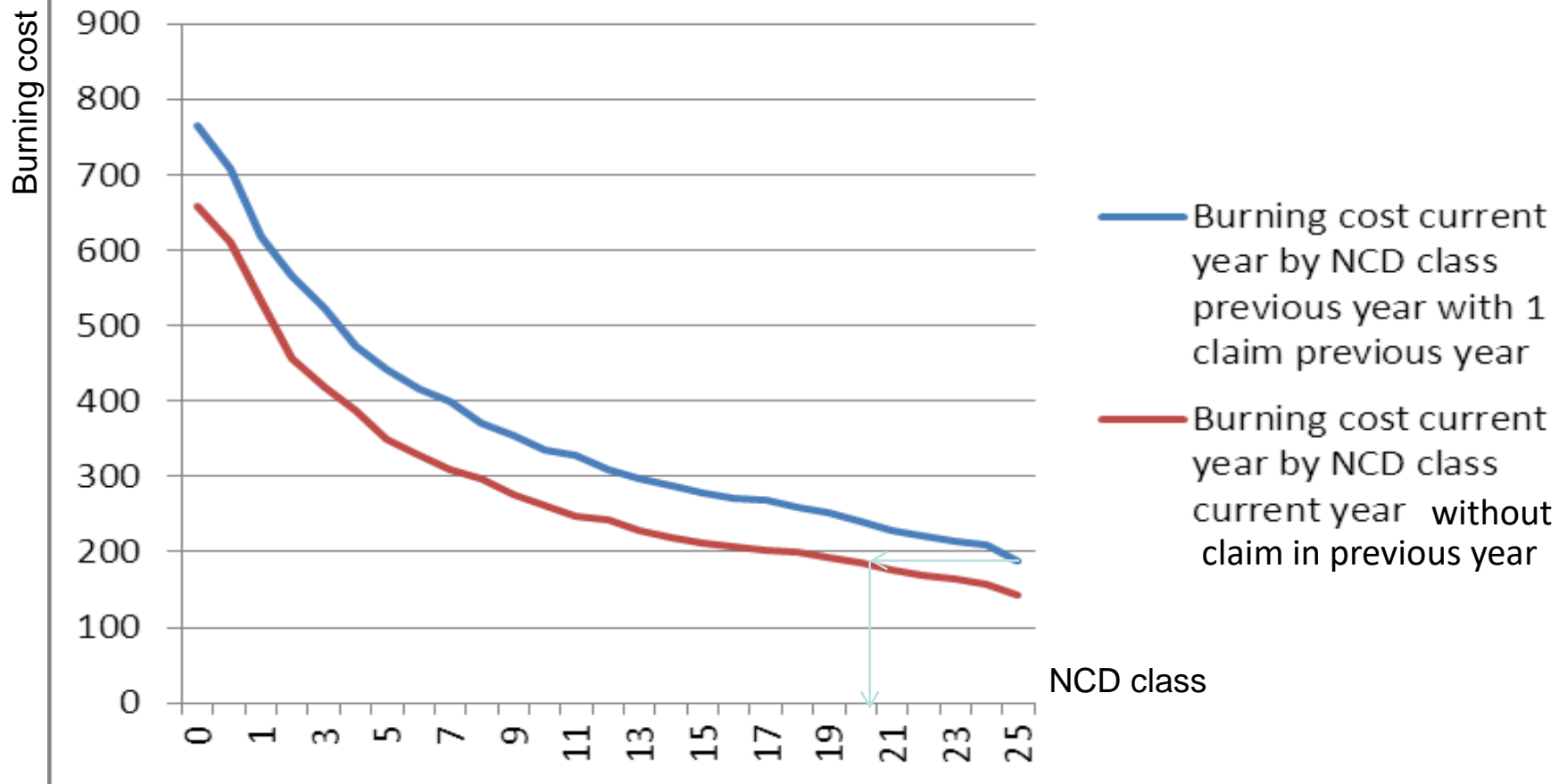
Burning costs by NCD class current year: see column claim free previous year allocated to one class upwards

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

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

7. Interaction of annual mileage with other criteria especially BMS

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. BMS: distance = 7.19
2. Type class: distance = 5.91
3. Age of user: distance = 2.84
4. Mileage: distance = 1.79

(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 live 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.

Many thanks for your attention! Questions?

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