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**ADJUSTMENT OF PARAMETERS OF A TARIFF  
NETWORK OF BONUS-MALUS SYSTEM IN LATVIA**

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**Abstract.** The majority of attention will be given to calculation transitive probabilities, considering payments, to calculation of base premiums, and also adjustment of percent of discounts and surcharges. All this information is necessary for adjustment of parameters of a tariff network of Bonus-Malus system in Latvia. After what it will be possible to draw up the optimum model of insurance.

**1 Introduction**

The Traffic Ministry published the first legislation about bonus-malus system analogue only in 1997. It called "The rules of insurance of civil liability premiums, its increase and decrease order and insurer's responsibility limits". There were three tables as an appendix:

1. "Discount table, if it is claim free year";
2. "Premium increase table" table;
3. "Premium increase table (if policyholder was under the alcohol or narcotic effect)" table.

Table 1. Discount table, if it is claim free year.

Years	Discount (%)	Code of discount	Years	Discount (%)	Code of discount
1	2	A1	7	15	A7
2	3	A2	8	20	A8
3	4	A3	9	25	A9
4	5	A4	10	30	A10
5	6	A5	11	40	A11
6	7	A6	12	50	A12

Table 2. Premium increase table.

Claims	Premium increase (%)	Code of increase
1	15	P1
2	30	P2
3	50	P3
4	75	P4
5 and more	100	P5

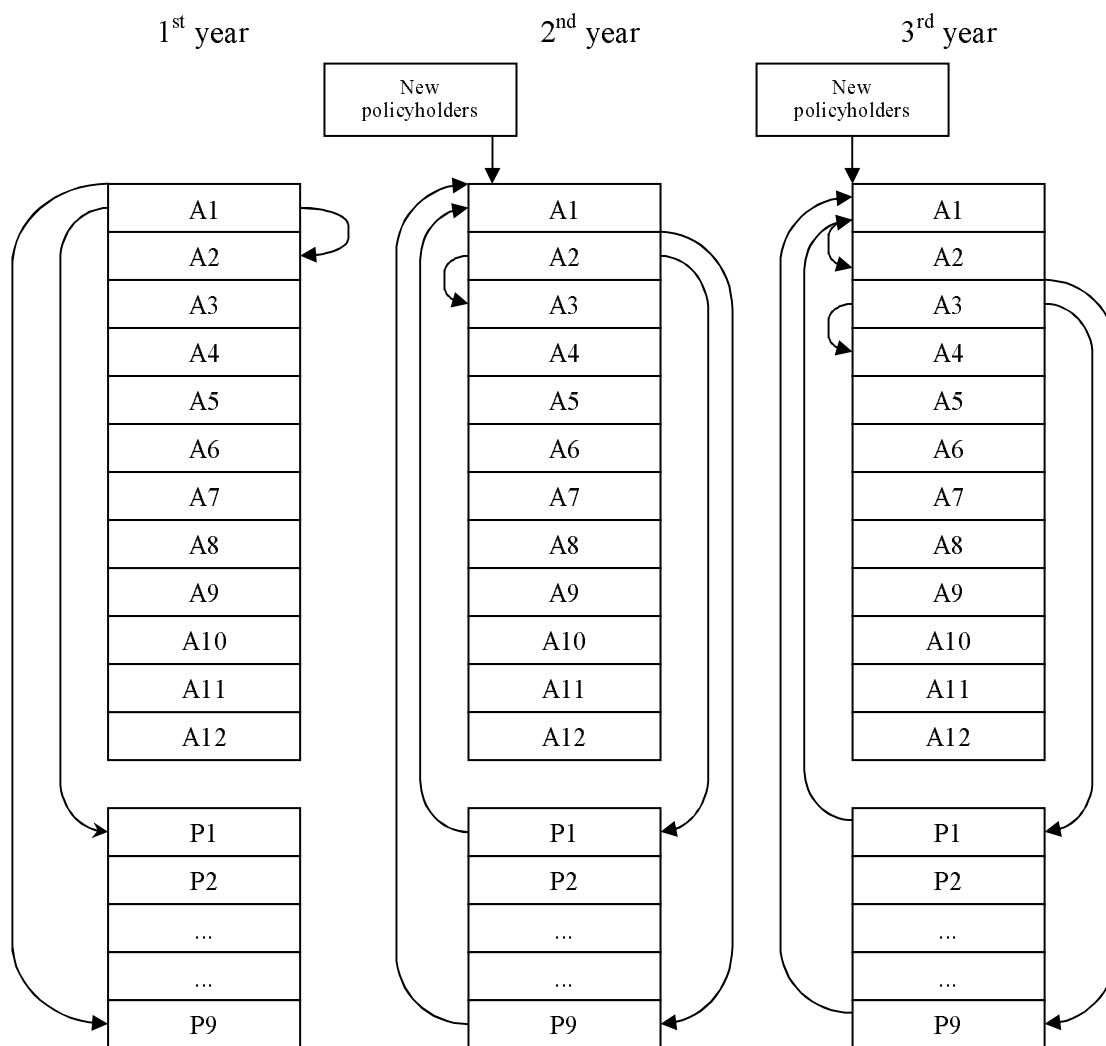
Table 3. Premium increase table (if policyholder was under the alcohol or narcotic effect)

Claims when policyholder was behind the wheel under the alcohol or narcotic effect	Premium increase (%)	Code of increase
1	50	P6
2 and more	100	P7
Under the alcohol effect	200	P8
Claim with human victim	100	P9

The Latvian system is simpler than European analogue. There is no need for a long history, and for getting the bonus or malus insurance company looks just previous year. And if a policyholder decides to change the insurance company, the previous history is useless. He or she starts from the primary class in the new company. Increase or decrease of premium payment depends of previous year. If he or she has claim free year then he or she will have a discount, but if there was a claim then policyholder will have an addendum issues. (See tables 1,2,3)

## 2 Latvian system model

There are “bonus” classes and “malus” classes in this system. If policyholder has claim free year he or she is in “bonus” class and he or she can have a discount, but if there is a claim during the same year he or she is in “malus” class and has an addendum cost. In tables 1,2,3 we can see the rates of discount and addendum percents. Using those tables we can model a graph of transitions from one class to another. (See Graph 1).



Graph 1. Transitions from one class to another.

### 3 Tariff network parameters

Using graph 1. and basing on official legislation we can calculate annual premiums, but at first we have to calculate transitive probabilities,

<b>Bonus classes</b>	<b>Malus Classes</b>
$A_1=0,98 * p$ ; where $A_1=n_1$	$P_1=1,15 * p$ ; where $P_1=n_1$
$A_2=0,97 * p$ ; where $A_2=n_2$	$P_2=1,30 * p$ ; where $P_2=n_2$
$A_3=0,96 * p$ ; where $A_3=n_3$	$P_3=1,50 * p$ ; where $P_3=n_3$
$A_4=0,95 * p$ ; where $A_4=n_4$	$P_4=1,75 * p$ ; where $P_4=n_4$
$A_5=0,94 * p$ ; where $A_5=n_5$	$P_5=2,00 * p$ ; where $P_5=n_5$
$A_6=0,93 * p$ ; where $A_6=n_6$	$P_6=1,50 * p$ ; where $P_6=n_6$
$A_7=0,85 * p$ ; where $A_7=n_7$	$P_7=2,00 * p$ ; where $P_7=n_7$
$A_8=0,80 * p$ ; where $A_8=n_8$	$P_8=3,00 * p$ ; where $P_8=n_8$
$A_9=0,75 * p$ ; where $A_9=n_9$	$P_9=2,00 * p$ ; where $P_9=n_9$
$A_{10}=0,70 * p$ ; where $A_{10}=n_{10}$	

$A_{11}=0,60*p$ ; where $A_{11}=n_{11}$	
$A_{12}=0,50*p$ ; where $A_{12}=n_{12}$	

where  $p$  - transitive probabilities;  $n_1, n_2, \dots, n_{12}$  - policyholders.  $P(S_v < U) \geq 0,98$ ; where  $U$  - necessary capital.  $S_v = x_1 + x_2 + \dots + x_v$ ; where  $S_v$  - summary expenses.

And we have to calculate the transitive probabilities:

$$0,98*p + 0,97*p + 0,96*p + 0,95*p + 0,94*p + 0,93*p + 0,85*p + 0,80*p + 0,75*p + 0,70*p + 0,60*p + 0,50*p + 1,15*p + 1,30*p + 1,50*p + 1,75*p + 2,00*p + 1,50*p + 2,00*p + 3,00*p + 2,00*p = S_v$$

$$p(0,98 + 0,97 + 0,96 + 0,95 + 0,94 + 0,93 + 0,85 + 0,80 + 0,75 + 0,70 + 0,60 + 0,50 + 1,15 + 1,30 + 1,50 + 1,75 + 2,00 + 1,50 + 2,00 + 3,00 + 2,00) = S_v$$

$$26,13*p = S_v \quad (*)$$

#### 4 Calculations

Each year using Graph 1 we have to calculate the amount of policyholders at first. Also we have to use transitive probabilities. After what we have to calculate the sum of claims. Let us say, that  $S_v$  will be summary expenses per month, where  $v$  - number of claims per month, and as we mentioned before  $S_v = x_1 + x_2 + \dots + x_v$ . Using first year data we will estimate values  $Ev$  and  $\delta v$ . Also we can estimate an expecting values  $Ex$  and  $\delta x$  of claim amount. Than using well known formulas:

$$ES_v = E_v * Ex_i \text{ and}$$

$$DS_v = E_v * Dx + (Ex)^2 D v,$$

we will manage an estimation.

Let us say, that  $S_v$  is normal distributed,  $S_v \sim N(ES_v; DS_v)$ , with parameters  $ES_v$  and  $DS_v$ , which are estimated before. Than, using the table of normal distribution, we locate a value

$$P(N(0, 1)) < 2,06 = 0,98.$$

After what:

$$\frac{S_v - ES_v}{\delta(S_v)} = 2,06 \Rightarrow S_v = \hat{E}S + 2,06 * \hat{\delta}(S_v) - \text{it is the formula on normal approximation, where}$$

$$\hat{E}S \text{ and } \hat{\delta}(S_v) \text{ are an estimated values.}$$

As we mentioned before, at first we have to calculate the amount of policyholders of all classes each year. Let us say that the amount of policyholders in each class in 2<sup>nd</sup> year will be  $n_1', n_2', \dots, n_{12}'$ . Using those values, we can say, that

$$n_1' * 0,98 * p + n_2' * 0,97 * p + n_3' * 0,96 * p + n_4' * 0,95 * p + n_5' * 0,94 * p + n_6' * 0,93 * p + n_7' * 0,85 * p + n_8' * 0,80 * p + n_9' * 0,75 * p + n_{10}' * 0,70 * p + n_{11}' * 0,60 * p + n_{12}' * 0,50 * p + n_1' * 1,15 * p + n_2' * 1,30 * p + n_3' * 1,50 * p + n_4' * 1,75 * p + n_5' * 2,00 * p + n_6' * 1,50 * p + n_7' * 2,00 * p + n_8' * 3,00 * p + n_9' * 2,00 * p = S_v, \quad (**)$$

and calculate basis premiums, in what we are interested in. In that way we will make calculations per each year. Using those calculations and equations (\*), (\*\*) and having concrete numbers, any insurance company can model their own tariff network and calculate basis premiums.

## 5 Conclusions and recommendations

Nowadays Bonus-Malus system is more popular in Latvia than previous years. In Europe all companies use policyholders' history for calculating premiums. Unfortunately we don't have unified policyholders' history database in Latvia. And that is the reason that each insurance company has their own discount calculation system. The official Bonus-Malus system gives small discount percents in first six discount classes, that is the reason that insurance companies give extra discounts to policyholder. But on the other hand there is a big competition among insurance companies in Latvia. That is why some insurance companies damp the prices, for example, 15 - 20%. If we compare the discount from the system for first year and these discount percents, we can see that system's discount is not beneficial for policyholder, and, of course, policyholders are not interested in this system.

The purpose of the given work was to simulate Bonus-Malus system using official legislation and practical calculations. Using the given work we can simulate such system of discounts, which will be favourable also to insurance companies and to policyholders.

## References

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