Bonus-malus system in Armenia

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Introduction

The Bonus-Malus system is a widely used method in the Motor Third-Party Liability (MTPL) insurance market, which adjusts premium rates based on the policyholder's claims history. This paper aims to examine the Bonus-Malus system in the Armenian MTPL market and propose a more relevant model that considers both the frequency and severity of claims. In recent years, the existing Bonus-Malus system in Armenia, which has been compulsory since 2013, has experienced disequilibrium, leading to significant financial losses for insurance companies.

Background

The Compulsory Motor Third-Party Liability (CMTPL) Bonus-Malus system in Armenia operates on the principle that safe drivers/policyholders should pay lower premiums compared to high-risk drivers/policyholders. The system initially assigned 4 malus classes for each claim made by policyholders, regardless of whether they were the driver or not (all malus classes were assigned to the policyholder). The Bonus-Malus system utilized a scale of values ranging from 0 to 22, with a policyholder starting at the base level of 10 and receiving 4 points based on their car's accident history. Additionally, policyholders who did not have any accidents within a 365-day period received one bonus point, leading to a reduction in their premium.
However, over the last 4-5 years, the Bonus-Malus system in Armenia has become imbalanced, resulting in a 93.6% disequilibrium in 2021. This disequilibrium has caused insurance companies in Armenia to lose approximately 7% of their yearly premiums. In response to this issue, changes have been implemented in the Bonus-Malus system to consider both the frequency and severity of claims based on the compensation size.

New Model

The new Bonus-Malus model, implemented in March 2022, takes into account both the quantity and amount of claims. For each claim, policyholders receive 3-8 malus classes based on the compensation amount, and they are rewarded with 1 bonus class for each claim-free year. To assess the model's effectiveness, a Markov chain was utilized to test its equilibrium over a 10-year period.
The new Bonus-Malus system has been modelled as a Markov chain with a finite state space. In contrast to the old system, the new model's malus classes are also connected to the claim size. The model construction is as follows:

P represents the probability matrix for different claim sizes over a 1-year period.

Probability of claim in one year						
	0-250$	**250-500$**	**500-1000$**	**1000-2500$**	**2500-4000$**	**4500$ AND MORE**
No claim	**88.475%**					
1 claim	5.597%	1.912%	1.795%	0.677%	0.309%	0.072%
2-nd claim	0.535%	0.203%	0.156%	0.060%	0.035%	0.007%
3-nd claim	0.075%	0.030%	0.018%	0.006%	0.003%	0.001%
4-nd claim	0.013%	0.006%	0.004%	0.001%	0.000%	0.000%
5-nd claim	0.003%	0.002%	0.001%	0.000%	0.000%	0.000%
6-nd claim	0.002%	0.000%	0.000%	0.000%	0.000%	0.000%
7-nd claim	0.001%	0.000%	0.000%	0.000%	0.000%	0.000%

C represents the class matrix for different claim sizes, indicating class changes for each claim

Class changes for a claim						
	0-250$	**250-500$**	**500-1000$**	**1000-2500$**	**2500-4000$**	**4500$ AND MORE**
No claim	-1					
1 claim	3	4	5	6	7	8
2-nd	3	4	5	6	7	8
3-nd	3	4	5	6	7	8
4-nd	3	4	5	6	7	8
5-nd	3	4	5	6	7	8
6-nd	3	4	5	6	7	8
7-nd	3	4	5	6	7	8

$S = \{s_1, s_2, ..., s_n\}$ represents the state space, where s_n represents the highest malus class and s1 represents the highest bonus class.
The transition matrix $T = [P_{ij}]$ represents the probability of moving from state s_i to s_j within a 1-year period.
$S_i = 25$ represents the maximum malus level, indicating a policyholder with a history of multiple claims and/or claims with the maximum amount of compensation.
Here we get 22 different P (probability) matrixes.
For 1-st class we will have the following P matrix.

Probability of claim in one year for policyholders in 1-st class						
	0-250$	**250-500$**	**500-1000$**	**1000-2500$**	**2500-4000$**	**4500$ AND MORE**
No claim	99.1413%					
1 claim	0.4440%	0.2045%	0.0993%	0.0701%	0.0175%	0.0000%
2-nd claim	0.0117%	0.0058%	0.0058%	0.0000%	0.0000%	0.0000%
3-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

4-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

As observed from the matrix above, policyholders in the 1st class have a very low probability of making claims. Based on this, we can derive the following probabilities for policyholders in the 1st class transitioning to other classes.

1	99.1413%
2	0.0000%
3	0.0000%
4	0.4440%
5	0.2045%
6	0.0993%
7	0.0763%
8	0.0235%
9	0.0059%
10	0.0031%
11	0.0014%
12	0.0006%
13	0.0001%
14	0.0000%
15	0.0000%
16	0.0000%
17	0.0000%
18	0.0000%
19	0.0000%
20	0.0000%
21	0.0000%
22	0.0000%

Here are the probability matrices for policyholders transitioning from classes 2 to 25, indicating the probabilities of making a claim:

Probability of claim in one year for policyholders in 2-nd class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	97.1277%					
1 claim	1.4258%	0.5252%	0.5415%	0.1632%	0.1083%	0.0000%

2-nd claim	0.0564%	0.0267%	0.0119%	0.0089%	0.0015%	0.0000%
3-nd claim	0.0015%	0.0000%	0.0015%	0.0000%	0.0000%	0.0000%
4-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 3-rd class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	95.8407%					
1 claim	2.2167%	0.7271%	0.6715%	0.2469%	0.1275%	0.0000%
2-nd claim	0.0936%	0.0298%	0.0298%	0.0081%	0.0027%	0.0000%
3-nd claim	0.0027%	0.0000%	0.0027%	0.0000%	0.0000%	0.0000%
4-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 4-th class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	94.9223%					
1 claim	2.7061%	0.8877%	0.8198%	0.3014%	0.1557%	0.0000%
2-nd claim	0.1143%	0.0364%	0.0364%	0.0099%	0.0033%	0.0000%
3-nd claim	0.0033%	0.0000%	0.0033%	0.0000%	0.0000%	0.0000%
4-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 5-th class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	91.3717%					
1 claim	4.5993%	1.4581%	1.3594%	0.5210%	0.2435%	0.0000%
2-nd claim	0.2404%	0.0709%	0.0555%	0.0247%	0.0154%	0.0000%
3-nd claim	0.0216%	0.0092%	0.0062%	0.0000%	0.0000%	0.0000%

4-nd claim	0.0000%	0.0031%	0.0000%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 6-th class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	89.7142%					
1 claim	5.2675%	1.6104%	1.7383%	0.6232%	0.3444%	0.0000%
2-nd claim	0.3477%	0.1181%	0.1082%	0.0394%	0.0164%	0.0000%
3-nd claim	0.0262%	0.0197%	0.0131%	0.0000%	0.0000%	0.0000%
4-nd claim	0.0000%	0.0033%	0.0000%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0033%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0033%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0033%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 7-th class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	90.5973%					
1 claim	4.8557%	1.6310%	1.4755%	0.5604%	0.3262%	0.0000%
2-nd claim	0.2868%	0.1226%	0.0744%	0.0241%	0.0241%	0.0000%
3-nd claim	0.0044%	0.0044%	0.0022%	0.0044%	0.0000%	0.0000%
4-nd claim	0.0000%	0.0044%	0.0000%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0000%	0.0000%	0.0022%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 8-th class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	89.6988%					
1 claim	5.2710%	1.6947%	1.6408%	0.6471%	0.3621%	0.0000%
2-nd claim	0.3794%	0.1387%	0.0693%	0.0366%	0.0193%	0.0000%
3-nd claim	0.0250%	0.0077%	0.0058%	0.0000%	0.0019%	0.0000%

4-nd claim	0.0019%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 9-th class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	88.8888%					
1 claim	5.6295%	1.8277%	1.7247%	0.7242%	0.3584%	0.0000%
2-nd claim	0.4062%	0.1434%	0.1434%	0.0523%	0.0269%	0.0000%
3-nd claim	0.0358%	0.0149%	0.0105%	0.0000%	0.0045%	0.0000%
4-nd claim	0.0030%	0.0030%	0.0015%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0000%	0.0015%	0.0000%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 10-th class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	82.6599%					
1 claim	8.4174%	2.9290%	2.7049%	1.0334%	0.5781%	0.0000%
2-nd claim	0.7779%	0.2940%	0.2070%	0.0942%	0.0614%	0.0000%
3-nd claim	0.1199%	0.0385%	0.0271%	0.0071%	0.0043%	0.0000%
4-nd claim	0.0257%	0.0029%	0.0029%	0.0014%	0.0014%	0.0000%
5-nd claim	0.0043%	0.0014%	0.0014%	0.0014%	0.0000%	0.0000%
6-nd claim	0.0014%	0.0000%	0.0014%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 11-th class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	84.3137%					
1 claim	6.9406%	2.6282%	2.6886%	0.9063%	0.5740%	0.0000%
2-nd claim	0.8685%	0.3701%	0.2870%	0.1359%	0.0378%	0.0000%
3-nd claim	0.1133%	0.0604%	0.0151%	0.0151%	0.0000%	0.0000%
4-nd claim	0.0151%	0.0076%	0.0151%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0076%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

6-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 12-th class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	84.5418%					
1 claim	7.4075%	2.4404%	2.3476%	0.7825%	0.4907%	0.0000%
2-nd claim	0.8621%	0.2852%	0.3382%	0.1525%	0.1459%	0.0000%
3-nd claim	0.0995%	0.0464%	0.0066%	0.0133%	0.0066%	0.0000%
4-nd claim	0.0265%	0.0000%	0.0066%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 13-th class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	83.5999%					
1 claim	7.4265%	2.7446%	2.3342%	0.9418%	0.6727%	0.0000%
2-nd claim	1.1368%	0.4238%	0.2489%	0.1413%	0.1009%	0.0000%
3-nd claim	0.1144%	0.0471%	0.0269%	0.0000%	0.0000%	0.0000%
4-nd claim	0.0202%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0135%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0000%	0.0000%	0.0067%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 14-th class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	79.2776%					
1 claim	8.6657%	3.1288%	2.8422%	1.0156%	0.6716%	0.0000%
2-nd claim	2.0149%	0.7535%	0.7044%	0.2130%	0.1802%	0.0000%
3-nd claim	0.2539%	0.1147%	0.0819%	0.0164%	0.0164%	0.0000%
4-nd claim	0.0410%	0.0000%	0.0082%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 15-th class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	82.4337%					
1 claim	6.9570%	3.4978%	2.7441%	0.8310%	0.5604%	0.0000%
2-nd claim	1.3334%	0.5024%	0.3672%	0.0966%	0.1159%	0.0000%
3-nd claim	0.3478%	0.0966%	0.0386%	0.0386%	0.0000%	0.0000%
4-nd claim	0.0193%	0.0000%	0.0193%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 16-th class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	81.6532%					
1 claim	7.6445%	2.7348%	3.1439%	1.1198%	0.4522%	0.0000%
2-nd claim	1.3566%	0.5383%	0.4953%	0.0646%	0.1292%	0.0000%
3-nd claim	0.3230%	0.1507%	0.0215%	0.0646%	0.0000%	0.0000%
4-nd claim	0.0431%	0.0215%	0.0000%	0.0000%	0.0215%	0.0000%
5-nd claim	0.0000%	0.0215%	0.0000%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 17-th class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	78.8425%					
1 claim	8.4000%	2.9925%	2.8875%	1.2075%	0.8925%	0.0000%
2-nd claim	2.0213%	0.6825%	0.6563%	0.1313%	0.1838%	0.0000%
3-nd claim	0.4988%	0.2100%	0.1838%	0.0525%	0.0263%	0.0000%
4-nd claim	0.0525%	0.0525%	0.0263%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 18-th class

	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	73.3232%					
1 claim	10.3414%	3.5240%	3.5898%	1.0539%	0.6916%	0.0000%
2-nd claim	2.4371%	1.3503%	0.8234%	0.3952%	0.1976%	0.0000%
3-nd claim	0.6916%	0.4611%	0.2635%	0.0988%	0.0988%	0.0000%
4-nd claim	0.1976%	0.1317%	0.0988%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0988%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0659%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0659%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 19-th class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	77.8495%					
1 claim	7.4998%	3.7499%	3.9243%	1.6569%	0.4360%	0.0000%
2-nd claim	2.2674%	0.5232%	0.6977%	0.1744%	0.0872%	0.0000%
3-nd claim	0.6977%	0.0872%	0.0872%	0.0000%	0.0000%	0.0000%
4-nd claim	0.0872%	0.0872%	0.0000%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0000%	0.0872%	0.0000%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 20-th class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	69.6263%					
1 claim	13.4345%	6.1332%	2.1417%	1.8497%	0.9735%	0.0000%
2-nd claim	1.7523%	1.1682%	0.8762%	0.4868%	0.2921%	0.0000%
3-nd claim	0.4868%	0.3894%	0.0000%	0.0000%	0.0974%	0.0000%
4-nd claim	0.0000%	0.1947%	0.0000%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0974%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 21-th class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE

No claim	71.9127%					
1 claim	11.0182%	5.5091%	4.5156%	1.8966%	0.9031%	0.0000%
2-nd claim	1.8063%	0.4516%	0.4516%	0.1806%	0.4516%	0.0000%
3-nd claim	0.5419%	0.1806%	0.0000%	0.0000%	0.0000%	0.0000%
4-nd claim	0.0000%	0.1806%	0.0000%	0.0000%	0.0000%	0.0000%
5-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
6-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

Probability of claim in one year for policyholders in 22-th class						
	0-250$	250-500$	500-1000$	1000-2500$	2500-4000$	4500$ AND MORE
No claim	55.0614%					
1 claim	16.4782%	5.6612%	4.5239%	1.2384%	0.8593%	0.0000%
2-nd claim	5.4085%	2.0471%	1.3142%	0.4044%	0.2275%	0.0000%
3-nd claim	1.6175%	0.5307%	0.4296%	0.1769%	0.0253%	0.0000%
4-nd claim	0.4549%	0.2527%	0.1769%	0.0505%	0.0253%	0.0000%
5-nd claim	0.1516%	0.1011%	0.0253%	0.0000%	0.0253%	0.0000%
6-nd claim	0.1011%	0.0505%	0.0000%	0.0000%	0.0000%	0.0000%
7-nd claim	2.5805%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%

From the provided P-probability matrices, we can derive the Ph_{ij} matrix, which represents the transition probabilities from state s_i to state s_j. Ph_{ij} denotes the probability that a policyholder moves from state s_i to state s_j within one year. These transition probabilities can be determined by dividing the claim probability by the claim sizes and considering the displacement between classes for different claim sizes.

However, since we are modifying our current system, it is crucial to calculate the transition probabilities specifically for policyholders already distributed in the BM classes. This ensures that the calculations reflect the existing distribution and dynamics of policyholders within the classes, rather than considering the total transition probabilities for all policyholders.

By applying the claim probability, claim sizes, and displacement between classes for different claim sizes to the policyholders' existing distribution within the BM classes, we can accurately calculate the transition probabilities of policyholders moving between states s_i and s_j.

Here is Ph_{ij} matrix.

Initial class	New class after one year																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	99.1%	0.0%	0.0%	0.4%	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
2	97.1%	0.0%	0.0%	0.0%	1.4%	0.5%	0.5%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3	0.0%	95.8%	0.0%	0.0%	0.0%	2.2%	0.7%	0.7%	0.3%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
4	0.0%	0.0%	94.9%	0.0%	0.0%	0.0%	2.7%	0.9%	0.8%	0.4%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5	0.0%	0.0%	0.0%	91.4%	0.0%	0.0%	0.0%	4.6%	1.5%	1.4%	0.7%	0.3%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
6	0.0%	0.0%	0.0%	0.0%	89.7%	0.0%	0.0%	0.0%	5.3%	1.6%	1.7%	0.8%	0.5%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7	0.0%	0.0%	0.0%	0.0%	0.0%	90.6%	0.0%	0.0%	0.0%	4.9%	1.6%	1.5%	0.7%	0.4%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
8	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	89.7%	0.0%	0.0%	0.0%	5.3%	1.7%	1.6%	0.9%	0.5%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
9	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	88.9%	0.0%	0.0%	0.0%	5.6%	1.8%	1.7%	0.9%	0.5%	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
10	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	82.7%	0.0%	0.0%	0.0%	8.4%	2.9%	2.7%	1.5%	0.9%	0.3%	0.2%	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%
11	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	84.3%	0.0%	0.0%	0.0%	6.9%	2.6%	2.7%	1.3%	0.9%	0.4%	0.3%	0.2%	0.1%	0.1%	0.0%	0.0%
12	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	84.5%	0.0%	0.0%	0.0%	7.4%	2.4%	2.3%	1.3%	0.8%	0.4%	0.3%	0.2%	0.1%	0.1%	0.1%
13	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	83.6%	0.0%	0.0%	0.0%	7.4%	2.7%	2.3%	1.5%	1.1%	0.4%	0.8%	0.2%	0.1%	0.1%
14	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	79.3%	0.0%	0.0%	0.0%	8.7%	3.1%	2.8%	2.1%	1.5%	2.5%	0.6%	0.5%	0.6%
15	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	82.4%	0.0%	0.0%	0.0%	7.0%	3.5%	2.7%	1.5%	1.1%	0.5%	0.4%	0.8%
16	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	81.7%	0.0%	0.0%	0.0%	7.6%	2.7%	3.1%	4.8%	1.0%	0.6%	1.3%
17	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	78.8%	0.0%	0.0%	0.0%	8.4%	3.0%	9.8%	2.2%	1.6%	2.9%
18	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	73.3%	0.0%	0.0%	0.0%	10.3%	16.3%	3.6%	2.4%	6.2%
19	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	77.8%	0.0%	0.0%	0.0%	22.2%	3.7%	3.9%	6.7%
20	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	69.6%	0.0%	0.0%	30.4%	13.4%	6.1%	10.5%
21	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	71.9%	0.0%	28.1%	0.0%	11.0%	16.9%
22	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	55.1%	0.0%	0.0%	0.0%	44.9%
23	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
24	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
25	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

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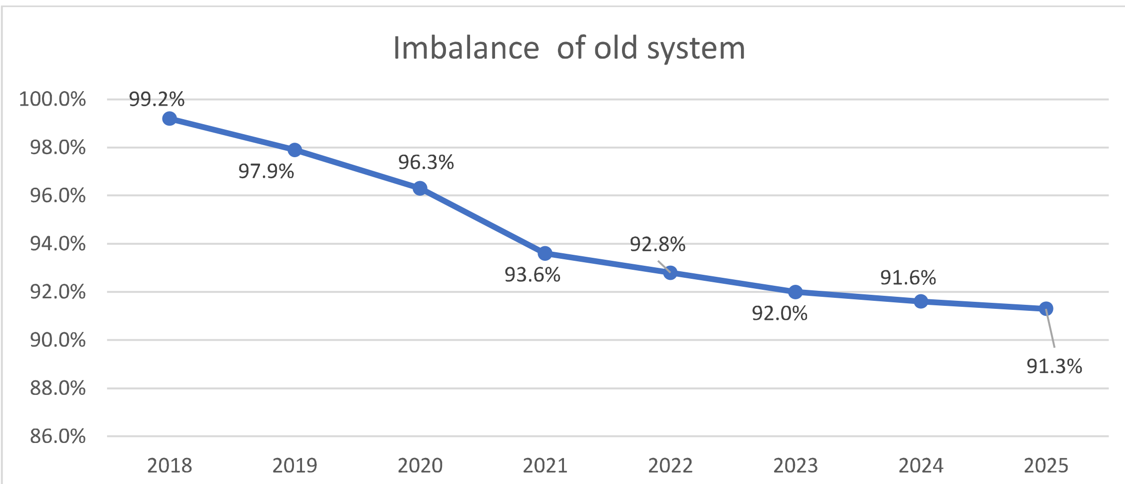
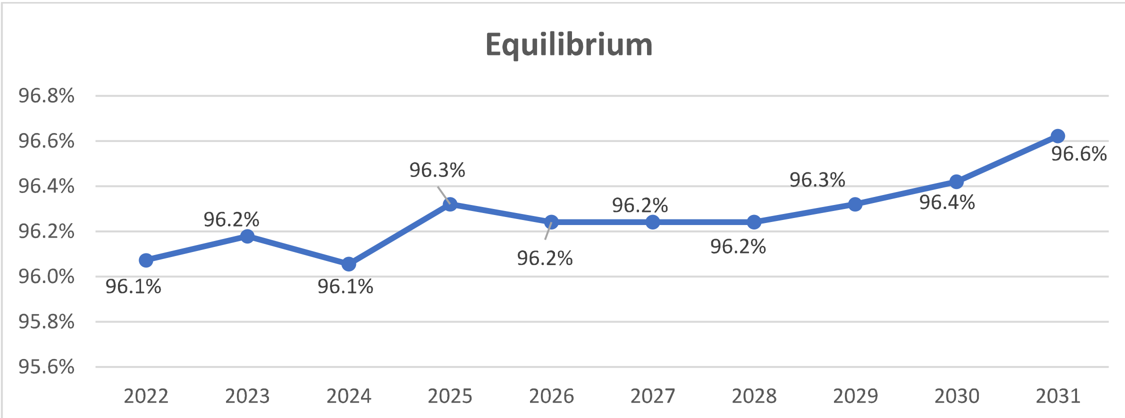
By utilizing the Markov chain, we can determine the optimal probabilities for each point and calculate the optimal bonus malus coefficients for every class. This ensures a balance between the bonuses and maluses assigned. Since there are policyholders already distributed across various classes, we have reconstructed the bonus malus (BM) system without altering the coefficients of the bonus classes. Our objective was to reach an equilibrium point by expanding the system up to the 25th malus class and adjusting the BM coefficients for the malus classes.
In the previous system, an imbalance of 93% had occurred, and this imbalance was progressively increasing each year. To address this issue, we implemented the revised system. Here is a graphical representation illustrating the imbalance of the bonus malus system over the years.



In the new system, we have successfully achieved equilibrium at a point of 96.6%. This was accomplished by running the Markov chain for a period of 10 years. Furthermore, for the subsequent 10 years, the system continues to maintain equilibrium around the 96.2% mark.
This indicates that the revised bonus malus system has effectively balanced the distribution of bonuses and maluses among policyholders, leading to a more stable and equitable outcome over an extended period of time.



Discussion The introduction of a more relevant Bonus-Malus (BM) system in the Armenian MTPL (Motor Third Party Liability) market is expected to bring about several positive changes.

This balance will be achieved by appropriately aligning premiums with individual driving behaviours and the level of risk they pose on the roads. As a result, drivers who consistently demonstrate safe driving habits will be rewarded with lower premiums, while those who engage in risky behaviours will face the appropriate financial consequences.

Not only will this new model help to improve road safety by incentivizing responsible driving, but it will also have positive implications for insurance companies. By encouraging safer driving practices, insurance companies can expect a reduction in the frequency and severity of claims, leading to improved profitability and sustainability in the long run.

It promotes fairer sentences by linking premiums to individual driving behaviours, encourages safer driving practices, and provides a practical solution for addressing small damages. This balanced approach will benefit both drivers and insurance companies, ultimately leading to improved road safety and a more sustainable insurance market.

Conclusion: This paper has proposed a more relevant Bonus-Malus system for the Armenian MTPL market by considering both the frequency and severity of claims. The new model, which assigns malus classes based on the compensation amount and grants bonus classes for claim-free years, has undergone testing and analysis using a Markov chain. The results demonstrate that the new model maintains equilibrium over a 10-year period. The implementation of this new system is expected to address the disequilibrium issue and provide a fair and balanced system for both insurance companies and policyholders in Armenia.